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PARAMETRIC SENSITIVITY ANALYSIS OF A REGIONAL INPUT-OUTPUT MODE--ETC(U)
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THESIS

PARAMETRIC SENSITIVITY ANALYSIS OF A REGIONAL INPUT-OUTPUT MODEL FOR FORECASTING SHORE-BASED NAVY WORKLOAD

by

Lee Thell Womack, Jr.

June 1980

Thesis Advisor: G. Thomas

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80 12 29 168

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER	2. GOVT ACCESSION NO. AD-A093 270
	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) (6) Parametric Sensitivity Analysis of a Regional Input-Output Model for Forecasting Shore-Based Navy Workload,	5. TYPE OF REPORT & PERIOD COVERED (9) Master's Thesis, ~~June 1980~~
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) (10) Lee Thell Womack, Jr.	8. CONTRACT OR GRANT NUMBER(s) (12) 111
9. PERFORMING ORGANIZATION NAME AND ADDRESS Naval Postgraduate School Monterey, California 93940	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS Naval Postgraduate School Monterey, California 93940	12. REPORT DATE (11) June 1980
	13. NUMBER OF PAGES 110
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)	15. SECURITY CLASS. (of this report) Unclassified
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Input-Output
Sensitivity Analysis
Parametric Row Analysis

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

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#20 - ABSTRACT - (CONTINUED)

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Parametric Sensitivity Analysis of a Regional Input-Output Model for Forecasting Shore-Based Navy Workload

by

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Lieutenant Commander, United States Navy
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Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE IN OPERATIONS RESEARCH

from the

NAVAL POSTGRADUATE SCHOOL
June 1980

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ACKNOWLEDGMENT

The author gratefully thanks Mrs. Janic M. Kissler of the Navy Personnel Research and Development Center for her precious assistance given in the assimilation of data and for helping the author to understand the workings of the model. Appreciation is extended to Adjunct Professor George W. Thomas of the Naval Postgraduate School who served as advisor on this thesis and to Assistant Professor Dan C. Boger of the Naval Postgraduate School who served as second reader on this thesis.

This thesis is dedicated in loving memory of the author's grandmother, Mrs. Pairlee Arnold.

I. INTRODUCTION

In 1978, the Navy Personnel Research and Development Center, located at San Diego, California, formulated "A Regional Input-Output Model For Forecasting Shore-Based Navy Workload" in the 11th Naval District. At the time of its formulation, this model was designed to forecast the workload of twenty shore-based activities within the 11th Naval District. This thesis is the result of a parametric sensitivity analysis of that model. In the sensitivity analysis, the author examined the output levels of the model when the input-output coefficient matrix was changed by a small amount in each row.

Input-output models may be categorized as being descriptive or prescriptive in nature depending upon 1) the goal or purpose of the model, 2) the applied use of the model, 3) the structure of the model, and 4) other related items. Within this broad categorization, it is useful to classify models in terms of their use. Input-output models may be classified as models of pure logical consistency or models of pure prediction.[1] A model of pure logical consistency deals only with the model's logical consistency. It addresses the question of whether or not certain events logically lead to certain

---

[1]Jones, C.R., A Taxonomy for Naval Force Level and Structure Models, working papers Naval Postgraduate School, Department of Operations Research and Administrative Sciences, Monterey, California, April, 1971.

other events. There are no empirical tests required to check this class of model. The pure prediction model generates forecasts or predictions for a subsequent time period. Empirical verification of this class of models may be done by comparing forecast and realized observations. "A Regional Input-Output Model For Forecasting Shore-Based Navy Workload" in the 11th Naval District is a member of the pure prediction class of models.

Section II of this thesis provides insight into how an input-output model is devised. In particular, it shows how the input-output coefficients are computed for each sector/activity of a general input-output model and gives a specific example of the formulation and workings of a very simple model. The mathematics of the general input-output model is gone through in detail and the model is reduced in form to a simple expression in matrix and vector notation.

Presented in Section III is, "A Regional Input-Output Model For Forecasting Shore-Based Navy Workload," the model formulated by the Navy Personnel Research and Development Center. A step-by-step breakdown of the model's formulation and background on how the data were gathered are given. Many years of data collection and analysis went into the formulation of the model. This section presents the method for aggregation of sectors and coefficients.

The methodology, chosen by this author, to do the sensitivity analysis on "A Regional Input-Output Model For Forecasting Shore-Based Navy Workload" in the 11th Naval District

is presented in Section IV. The decision to do a parametric sensitivity analysis on the Input-Output Coefficient Matrix, A, and to only parametrize rows as opposed to rows and columns or some combination of rows, columns, and individual elements of the input-output coefficient matrix is explained. Also, the choice of change values, for parametrization, of between minus 25 percent and plus 25 percent is explained. The procedure for computing the output level of the parametrized row/sector is outlined as is the procedure for computing the Baseline Output Level used in the calculation of percentage changes in the output levels of the twenty sectors of the model. The crux of this thesis is the sensitivity analysis of the output level of a sector based on a parametric change to that sector's row of the input-output coefficient matrix and the manner in which this was done is outlined in this section.

The results of the methodology outlined in Section IV, when applied to "A Regional Input-Output Model For Forecasting Shore-Based Navy Workload," are given in Section V. Upper and lower bounds on the percentage change in the output level of a parametrized sector are computed and graphed for the twelve sectors this author felt to be of concern. These graphs are presented as Figures 3 through 14 of Section V. The lower bounds showed a linear relationship with the delta values used for parametrization to compute the percentage change in the output level for a particular sector. The same was true for the computed upper bounds.

Conclusions and recommendations are given in Section VI. The fact that the Public Works Center was the most sensitive sector of the model and how this was determined are presented. Inter-sectoral relationships are discussed and the recommendation to reevaluate the input-output coefficient matrix in terms of the zero entries is made.

II. THE GENERAL INPUT-OUTPUT MODEL AND RELATED MATHEMATICS

The classical Leontief Input-Output Model consists of three basic elements. A square matrix, B, is used to represent the industrial classification of an economy. Each row of the matrix, B, contains the amount of a particular industry's final product that is used as input for producing the final product of industries represented in the columns of the matrix. A separate row vector is used to denote the amount of each primary factor, or input such as labor, required by each industry in the economy. Finally, a separate column vector is used to provide the amount of exogenous demand that exists for each final product [11;13].

As a simplified example, consider the two-industry economy in which industry one produces water and industry two produces electricity. If b_{ij} denotes the quantity of the i^{th} industry's final product used by the j^{th} industry, then it follows that b_{11} represents the amount of water used in the production of water and b_{12} represents the amount of water used in the production of electricity. In a physical sense, b_{11} represents the water used to cool and supply evaporators, other plant devices, and other related activities of the two producing industries. In a likewise manner, b_{21} and b_{22} represent the amount of electricity used to operate lights and other electrical components in the water and electrical industries respectively. The components b_{11}, b_{12}, b_{21}, and b_{22} comprise

the square matrix, B. Inasmuch as this is a two-industry economy example, the amount of labor required can be represented by x_{01} and x_{02} and the exogenous demand for each final product by d_1 and d_2. The total real output of the two industries can be represented as x_1 and x_2. Figure 1 is that of the general model for an n-industry economy.

The details of solving the two-industry economy problem are presented as an introduction to the methodology used in working with an input-output model. The solution procedure deals with the problem of determining the appropriate levels of output at which the two industries should operate such that production just satisfies the total demand for a final product. Simply stated, equilibrium exists in the two-industry economy when the total outputs of industry one and those of industry two are in balance so that just enough of each is produced to satisfy both the final demand and the input requirements for each product. In the general case, the two-industry economy becomes an n-industry economy and the solution is analogous to the two-industry discussion.

To solve the two-industry problem, let x_1 and x_2 represent the total outputs of industries one and two respectively. These quantities are represented as row sums in Figure 1. It is assumed that the input-output coefficients are constant [10] and that the transformation of inputs into outputs is accomplished in a linear fashion. From the discussion of the two-industry economy it follows that for each unit of the j^{th} commodity produced, a fixed input of the i^{th} commodity is

	Industry 1	Industry 2		Industry j		Industry n	Final Consumption	Total Output
Industry 1	b_{11}	b_{12}	. . .	b_{1j}	. . .	b_{1n}	d_1	x_1
Industry 2	b_{21}	b_{22}	. . .	b_{2j}	. . .	b_{2n}	d_2	x_2
	.	.		.		.	.	.
	.	.		.		.	.	.
	.	.		.		.	.	.
Industry i	b_{i1}	b_{i2}	. . .	b_{ij}	. . .	b_{in}	d_i	x_i
	.	.		.		.	.	.
	.	.		.		.	.	.
	.	.		.		.	.	.
Industry n	b_{n1}	b_{n2}	. . .	b_{nj}	. . .	b_{nn}	d_n	x_n
Labor	x_{01}	x_{02}	. . .	x_{0j}	. . .	x_{0n}		

Figure 1. The Classical Leontief Model.

required. In other words, a unit of output of water or electricity requires a fixed input of water or electricity respectively.

The input-output matrix, A, may be derived from the inter-industry relationships. In general, the input-output coefficients are defined by

$$a_{ij} = b_{ij}/x_j,$$

where a_{ij} represents the amount of output of industry i used in the production of one unit of output of industry j, b_{ij} represents the input by industry j to industry i, and x_j represents the total real output by industry j. Thus, the input-output coefficients for the two-industry problem are $a_{11} = b_{11}/x_1$, $a_{12} = b_{12}/x_2$, $a_{21} = b_{21}/x_1$, and $a_{22} = b_{22}/x_2$.

The total output requirements, x_1 and x_2 may now be expressed as:

$$x_1 = a_{11}x_1 + a_{12}x_2 + d_1$$

and

$$x_2 = a_{21}x_1 + a_{22}x_2 + d_2.$$

Solving these two equations for d_i yields:

$$d_1 = (1 - a_{11})x_1 - a_{12}x_2$$

and

$$d_2 = -a_{21}x_1 + (1 - a_{22})x_2.$$

Expressing these algebraic expressions in matrix notation is as follows:

$$\begin{bmatrix} (1 - a_{11}) & -a_{12} \\ -a_{21} & (1 - a_{22}) \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} = \begin{bmatrix} d_1 \\ d_2 \end{bmatrix} .$$

The above matrix notation may be compactly written as

$$(I-A)\bar{x} = \bar{d}.$$

This compactly written matrix notation will be used throughout the thesis with A denoting the matrix of a_{ij}s, $\bar{x}$ denoting the vector of outputs, $\bar{d}$ denoting the vector of exogenous demands, and I denoting the identity matrix (the n x n matrix with 1s on the principal diagonal and 0s elsewhere). Solving the above expression for $\bar{x}$ completes the problem and it follows that $\bar{x} = (I-A)^{-1}\bar{d}$. Now, it can be seen that the appropriate level of output for each of the two industries is uniquely determined for a given exogenous demand.

The assumptions relating to the Classical Leontief Input-Output Model will now be addressed. The first assumption

relating to a single output for each sector poses no conceptual problems. However, the assumption relating to the constancy of input-output coefficients has been the subject of major criticism of the model. A very enlightening discussion relating to the constancy of the technological coefficients is provided by Hatanaka [10]. Hatanaka's first area of criticism relates to weaknesses resulting from ignoring certain factors considered in production theory. He specifically categorizes shortcomings as being the result of ignoring or overlooking one or more of the basic factors of production. First, the model ignores the occurrence of price substitution. Price substitution, however, is a very real phenomenon since choice among alternative inputs is very dependent on relative input prices. Second, no accounting is made for economies or diseconomies of scale for inputs which are consumed by output elements. Third, certain factors of production, which are outside the model, are ignored. This criticism results from a failure of the model to account for such things as capital stock depletion of natural resources. Fourth, the model fails to account for joint production. This shortcoming results from the establishment of a single output measure for each of the model's input elements. An example of this joint production is the production of wool and mutton. During the lifetime of a sheep, the hair from its body is sheared and this hair is converted into wool. As the sheep matures and is full grown, it is slaughtered and the flesh of the animal is then offered up as mutton. Thus, the sheep growing industry outputs

a joint product; wool from young sheep and mutton from more mature sheep. Fifth, and last, the model fails to account for technological progress during the time-frame under consideration as the input-output coefficients are assumed to remain constant.

A second area of criticism relates to weaknesses that may occur as a result of the manner in which an actual model is constructed. Difficulties may arise as a result of the manner in which industries are defined and can be affected by the time when data are measured. The result can be that the input-output coefficients may change as a result of the manner in which the model is aggregated, or as a result of a change in the mixture of old and new production procedures. To visualize the effect of the manner of aggregation, assume that there are, in fact, two constant coefficients. If these coefficients are added during aggregation of the model, there is no longer any reason to assume that the constancy of individual coefficients has been preserved. The mixing of old and new production procedures can be clearly illustrated by considering an industrial firm that is faced with a reduction in demand for its product. Assume, for the purpose of this example, that an industry does, in fact, operate an old and a new production process in producing its output. When the industry's sales decrease, it will undoubtedly cut back on production by the old process. As business improves, and sales begin to increase, the firm will probably choose to

expand by increasing its new process and then use the old process as capacity utilization increases. The end result will be that the relative proportions of old and new production lines will have changed and hence, the input-output coefficients will have changed. A final problem may result from the methodology used in building the model. This relates to what Hatanaka [10] calls the dilemma of aggregation. This problem relates to the two-sided nature of input-output analysis, or the fact that one must study the industry's providing role of furnishing its output as input to an intermediate or final output industry and also the industry's consuming role of using supplied inputs in the production of outputs.

The problem of model validation can present additional difficulties. There are essentially two approaches that may be taken to determine the ability of a model to provide accurate forecasts. The difference in these approaches is related only to the time period for which the predictions are made. One method of prediction is to construct a model now and predict subsequent outputs. The other possibility is to use historical data, available in the economy, to build a model and predict outputs for which a realized value already exists. "A Regional Input-Output Model For Forecasting Shore-Based Navy Workload" in the 11th Naval District was validated using the latter approach.

III. THE NAVY PERSONNEL RESEARCH AND DEVELOPMENT CENTER'S REGIONAL INPUT-OUTPUT MODEL

The Navy Personnel Research and Development Center, located at San Diego, California, using the techniques of input-output modeling, formulated "A Regional Input-Output Model For Forecasting Shore-Based Navy Workload." This model was a quantitative tool to forecast workload at various 11th Naval District shore activities based on a specific cleet configuration. The input-output, I/O, model was developed as a means by which I/O analysis could capture and accurately measure the multitude of workload demands Navy activities place on each other. It could also help in determining the feasibility and cost of developing a Navy-wide I/O model and it could be used to explore any mathematical and/or computational problems that might be associated with the formulated model [7].

In developing a system for allocating shore-based manpower resources in the 11th Naval District, major emphasis was placed on the design of an I/O model to forecast the workload of shore/support activities based on size and configuration of the fleet. By organizing Navy shore activities into an I/O matrix, the extent to which each activity depended on every other activity to produce support could be quantified using historical data. I/O analysis was seen as a tool to determine, for example, the impact on Long Beach Naval Shipyard's workload

of introducing an additional destroyer into the overhaul schedule. Also, it could help estimate the increased work necessary at the Naval Supply Center, San Diego, California, to service more shipyard requisitions in support of the overhaul of the additional destroyer. Thus, both direct and indirect effects of the fleet were captured in the model.

The regional I/O model was formulated as a standard linear program [7:9] with the objective being to minimize total activity output while satisfying both final and intermediate demands for that output. The I/O sectors represented 11th Naval District shore-based activities with final demands represented by the ships and aircraft of the fleet.[2]

The regional I/O model formulation was:

$$\text{Minimize}^{3} \quad Z = \sum_{i=1}^{m} x_i$$

subject to:

$$(I - A)\,\overline{X} \geq \overline{d}$$
$$\overline{X} \geq 0$$

---

[2]Shore-based activities not included as I/O sectors were treated as final demands on the system.

[3]The I-A matrix was a square matrix and so the solution to the model had to be a point solution. Thus, the objective function served no purpose except to formulate the model as a linear programming problem. Hence, the objective function could be dropped since the "subject to" conditions determine the unique solution to the model.

where:

m = number of I/O sectors,

x_i = total required output level of sector i,

d_i = final demand on sector i,

$A = [a_{ij}]$ = amount of input required by sector j from sector i to product one unit of output from sector j, and

I = identity matrix.

Final demand, d_i, for a sector was treated as a constant on the right-hand side of the linear programming formulation. Therefore, calculation of final demand for a sector by fleet size, mix, location, and operating tempo was done outside the LP model and then summed up.

The formulation of the final demand model was:

$$d_i = \sum_{j=1}^{J} \sum_{k=1}^{K} \sum_{h=1}^{H} n_{jkh} t_{jkh} r_{ijkh}$$

where:

n_{jkh} = number of ships of type j, homeport k, and status h,[4]

t_{jkh} = average time spent in status h by a ship of type j and homeport k,

---

[4]A ship would be in one of the following statuses: in port, in overhaul, on local operations, or on extended cruise.

r_{ijkh} = average demand rate for sector i goods of ships of type j, homeport k, and status h,

J = number of ship types,

K = number of homeports, and

H = number of statuses (e.g., "in-port" or "over-haul").

Nine major 11th Naval District shore activities were studied in detail to develop an I/O model representing the fleet-support demand network. The activities were selected for their (1) wide range of functions, outputs, and data problems, (2) manpower intensities, and (3) direct and indirect linkages to the fleet. An I/O formulation of the fleet-support problem required the creation of economic sectors, each of which produced a single, unique output. While the workload of many shore activities could be characterized by a single output measure, other activities produced several distinct outputs. Thus, it was necessary to divide multioutput activities into several sectors, which increased the number of I/O sectors in the model to twenty. Demands placed on the system by units not included in this set of twenty sectors are all treated as final demands on the system. This includes other 11th Naval District shore activities, Navy activities in other geographical areas, and the operating units, ships and aircraft, of the fleet. A list of the twenty I/O sectors of the model and the units that were used to measure their total workload are shown in Table I.

Table I

I/O Model Sectors

	Sector/Activity	Output Measure
1	Naval Supply Center San Diego	Requisitions
2	Long Beach Naval Shipyard	Man-days of Ship Repair
3	San Diego-based Intermediate Maintenance Activities	Man-hours of Intermediate Maintenance
4	Naval Air Rework Facility North Island	Manhours of Air Rework
5	Public Works Center (PWC) San Diego	Man-hours of Direct Labor
6	PWC--Facilities Maintenance	Man-hours of Facilities Maintenance
7	PWC--Transportation	Gallons of Fuel
8	PWC--Utilities	Million BTU's of Energy
9	Naval Regional Medical Center, San Diego	Admissions[5]
10	Naval Regional Medical Center, San Diego	Outpatient Visits[5]
11	Naval Station--Military Personnel	Military Personnel Actions
12	Naval Station--Port Services	Port Service Hours
13	NAS Miramar--Air Operations	Air Operations
14	NAS Miramar--Aircraft Intermediate Maintenance	Man-hours of AIM
15	NAS Miramar--Supply	Requisitions
16	NTC--Recruit Training	Students
17	NTC--Service Schools	Students

Table I (Cont'd)

18	Manpower--Active Duty Navy	Personnel
19	Manpower--Dependents of Active Duty Navy	Personnel
20	Manpower--civilian	Personnel

---

[5]A weighted average of Admissions and Outpatient visits was used for the output measure.

To develop an I/O coefficient matrix for the model, it was necessary to study each activity in the model. This series of investigations enabled the determination of each sector's level of output and the distribution of that output among the other sectors of the model, as well as the units which make up final demand [1;2;3;4;5;6;8;12;14]. At each activity, average demand rates were calculated over the most recent period of time for which data were available, generally FY75-77.

In addition to the flow of goods and services between sectors of the model, the analysis of activities that serve the fleet directly required the estimation of final demand rates for the San Diego-based operating units of the Pacific Fleet. This involved examining the level of demand placed on an activity by each of the approximately 120 ships homeported in San Diego. These demand rates were categorized by ship type and status. Similar analyses were performed to determine the level of workload required to service each type of aircraft at the Naval Air Rework Facility. Using these rates, the model was able to compute the effect on final demand and total output caused by changes in the size and deployment status of operating units of the fleet.

Since workload at some of the Navy activities could only be measured in terms of two or more outputs, special estimation techniques had to be used to model the distribution of goods and services among model sectors that were a part of the same Navy

activity. It was not feasible to attempt to trace each input purchased by an activity to the production department from which one of its outputs came; hence, certain assumptions were made concerning the internal use of inputs within these activities.

The matrix shown as Figure 2 illustrates the economic interactions among sectors of the model. The marked cells indicated the location of nonzero elements in the I-A matrix. Thus, a nonzero entry in element (i,j) of the matrix indicated that the output of sector i was used directly in the production of sector j's output. As an example, element (1,2) of the matrix indicated an interaction between the Navy Supply Center and Long Beach Navay Shipyard. This meant that at least one requisition was processed by the Navy Supply Center for Long Beach Naval Shipyard and that a change in the shipyard workload would in some way impact the workload at the supply center.

In an effort to give the reader a working knowledge of the input-output coefficient matrix, the first row of A and the first column of A will be derived. First, the input matrix, B, was constructed by collecting data on inputs to each of the twenty sectors of the model from each sector of the model. The first row of the B matrix will now be constructed. Table II is a table of the first row of the input matrix, B. During the base period of FY75-77, The Navy Supply Center, NSC, generated 6131 requisitions internally which had to be processed by NSC. Thus, the input to sector one, NSC, from sector one,

Sector	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1. Supply Center	X	X	X	X	X				X			X	X			X	X			
2. Shipyard		X																		
3. IMAs			X									X								
4. NARF				X																
5. Public Works					X	X	X	X												
6. Facilities Maintenance	X		X		X	X			X			X				X	X			
7. Transportation	X		X		X		X		X			X				X	X			
8. Utilities	X		X		X			X	X			X				X	X			
9. NRMC Admissions									X									X	X	
10. NRMC Outpatients										X								X	X	
11. Military Personnel Dept.											X									
12. Port Services												X								
13. NAS Miramar--Air Ops													X							
14. NAS Miramar--AIMD														X						
15. NAS Miramar--Supply														X	X					
16. Recruit Training																X				
17. Service Schools																	X			
18. Active Duty Navy	X	X	X	X	X				X			X	X			X	X	X		
19. Dependents																		X	X	
20. Civilians	X	X	X	X	X				X			X	X			X				X

Figure 2. 11th Naval District Regional I/O Model Impact Matrix.

Table II

Row One of the Input Matrix, B

Sectors 1- 5	6131	83387	98472	81634	1090
Sectors 6-10	0	0	0	131589	0
Sectors 11-15	0	6220	64894	0	0
Sectors 16-20	9069	4282	0	0	0
Read across the rows.					

NSC, was 6131 requisitions and this number was placed in the B matrix as $b_{1,1}$. Similarly, Long Beach Naval Shipyard, sector two, generated 83387 requisitions which NSC processed. This number was placed in the B matrix as $b_{1,2}$. Entries $b_{1,3}$, $b_{1,4}$, and $b_{1,5}$ were similarly derived. All requisitions for the Public Works Center were generated on the administrative side of the house of the Public Works Center, hence, Public Works Center--Facilities Maintenance, Public Works Center--Transportation, and Public Works Center--Utilities had no input of requisitions. Thus, $b_{1,6}$, $b_{1,7}$, and $b_{1,8}$ were zero. The Naval Regional Medical Center at San Diego generated 131589 requisitions which were processed by NSC. Since requisitions were only generated in the administrative side of the house of Naval Regional Medical Center, all requisitions were put into the admissions sector, sector, nine, and so the Naval Regional Medical Center--Outpatients sector, sector ten, had no input. All requisitions submitted to NSC from the Naval Station at San Diego, 6220 requisitions, were processed as Naval Station

Port Services requisitions and so Naval Station Military Personnel, sector eleven, had no input. As a result of this, $b_{1,11}$ became zero and $b_{1,12}$ became 6220. NAS Miramar submitted a total of 64894 requisitions to NSC and all were processed as NAS Miramar--Air Operations, sector thirteen, requisitions. Thus, $b_{1,13}$ became 64894. Since all NAS Miramar requisitions were processed as sector thirteen requisitions, NAS Miramar--Aircraft Intermediate Maintenace, sector fourteen, and NAS Miramar--Supply, sector fifteen, had no inputs to the matrix. Consequently, $b_{1,14}$ and $b_{1,15}$ were zero. Naval Training Center--Recruit Training, sector sixteen, submitted 9069 requisitions to NSC. Naval Training Center--Service Schools Command, sector seventeen, submitted 4282 requisitions to NSC. The last three sectors of the model were accounting sectors to track personnel only and so no requisitions were submitted from these sectors. Thus, Manpower--Active Duty Navy, sector eighteen, Manpower--Dependents of Active Duty Navy, sector nineteen, and Manpower--Civilian, sector twenty, had no inputs to the B matrix for NSC, sector one. This completed the first row of the B matrix, the row that represented the Naval Supply Center.

The first column of the B matrix was derived in a similar manner to the first row of the matrix and Table III is a table of the first column of the input matrix, B.

The Naval Supply Center input, $b_{1,1}$ remained unchanged. No man-days of ship repair from Long Beach Naval Shipyard, sector two, were used by NSC, sector one, thus $b_{2,1}$ was zero.

Table III

Column One of the Input Matrix, B

Sectors 1- 5	6131	0	0	0	0
Sectors 6-10	11734	69983	88906	0	0
Sectors 11-15	0	0	0	0	0
Sectors 16-20	0	0	21	0	740

Read across the rows.

Similarly, no man-hours of intermediate maintenance from San Diego-based Intermediate Maintenance Activities, sector three, were used by NSC. No man-hours of air rework from the Naval Air Rework Facility at North Island, sector four, were used by NSC and no man-hours of direct labor from the Public Works Center, sector five, were used by NSC. NSC did utilize 11734 man-hours of facilities maintenance from the Public Works Center--Facilities Maintenance, sector six. The Public Works Center--Transportation, sector seven, contributed 69983 gallons of fuel to the operation of NSC. In order to heat buildings of NSC and run auxiliary equipments, Public Works Center--Utilities, sector eight, provided 88906 million BTU's of energy to NSC. The only other sectors to provide inputs to NSC were Manpower--Active Duty Navy, Sector eighteen, 21 personnel, and Manpower--Civilian, sector twenty, 740 personnel. Since no other sectors had inputs, $b_{9,1}$, $b_{10,1}$, $b_{11,1}$, $b_{12,1}$, $b_{13,1}$, $b_{14,1}$, $b_{15,1}$, $b_{16,1}$, $b_{17,1}$, and $b_{19,1}$ were all assigned the value zero. This completed the first column of the B matrix.

The remainder of the B matrix was filled in using the same techniques as just shown for row one and column one.

With the B matrix completed, the next task was to compute the input-output coefficients and put them in the A matrix. This was done by dividing the inputs in the columns of the B matrix by the total real output, during the base period, of the corresponding sectors. Table IV is a table of the first row of the input-output coefficient matrix, A.

Table IV

Row One of the Input-Output Coefficient Matrix, A

Sectors 1- 5	0.00580	0.10500	0.03410	0.01260	0.00560
Sectors 6-10	0.0	0.0	0.0	0.45510	0.0
Sectors 11-15	0.0	0.62920	0.59300	0.0	0.0
Sectors 16-20	1.64000	0.90800	0.0	0.0	0.0

Read across the rows.

To illustrate the procedure described above, some of the elements of the input-output coefficients for the Naval Supply Center, sector one, row one of the A matrix will now be calculated. To compute $a_{1,1}$ element $b_{1,1}$ was divided by the total real output for NSC, sector one, X_1. The total real output for each of the twenty sectors may be found in Table VI.

$$a_{1,1} = b_{1,1}/X_1 = 6131/1057143 = 0.00580.$$

The element $a_{1,2}$ was computed by taking the element $b_{1,2}$ and dividing it by the total real output for Long Beach Naval Shipyard, sector two, which gave

$$a_{1,2} = b_{1,2}/X_2 = 83387/794165 = 0.10500 \text{ requisitions/man-day.}$$

The element $a_{1,3}$ was computed by taking the element $b_{1,3}$ and dividing it by the total real output for San Diego-based Intermediate Maintenance Activities, sector three. This gave

$$a_{1,3} = b_{1,3}/X_3 = 98472/2887755 = 0.03410 \text{ requisitions/man-hour.}$$

Since the elements $b_{1,6}$, $b_{1,7}$, $b_{1,8}$, $b_{1,10}$, $b_{1,11}$, $b_{1,14}$, $b_{1,15}$, $b_{1,18}$, $b_{1,19}$, and $b_{1,20}$ were zero the elements $a_{1,6}$, $a_{1,7}$, $a_{1,8}$, $a_{1,10}$, $a_{1,11}$, $a_{1,14}$, $a_{1,15}$, $a_{1,18}$, $a_{1,19}$, and $a_{1,20}$ were assigned the value zero. This completed the first row of the input-output coefficient matrix, A.

To calculate the values of the input-output coefficients in the first column of A, similar logic was used. Table V is a table of the first column of the input-output coefficient matrix, A. The first element, $a_{1,1}$ was computed above and so it did not have to be recomputed. The element $a_{6,1}$ was computed by taking $b_{6,1}$ and dividing it by the total real output for NSC, sector one, which gave

$$a_{6,1} = b_{6,1}/X_1 = 11734/1057143 = 0.01110 \text{ man-hours/requisition.}$$

Table V

Column One of the Input-Output Coefficient Matrix, A

Sectors 1- 5	0.00580	0.0	0.0	0.0	0.0
Sectors 6-10	0.0110	0.6220	0.08410	0.0	0.0
Sectors 11-15	0.0	0.0	0.0	0.0	0.0
Sectors 16-20	0.0	0.0	0.00002	0.0	0.00070

Read across the rows.

The element $a_{20,1}$ was computed by taking $b_{20,1}$ and dividing it by the total real output for NSC, sector one, as

$$a_{20,1} = b_{20,1}/X_1 = 740/1057143 = 0.00070 \text{ personnel/requisition.}$$

The elements $b_{2,1}$, $b_{3,1}$, $b_{4,1}$, $b_{5,1}$, $b_{9,1}$, $b_{10,1}$, $b_{11,1}$, $b_{12,1}$, $b_{13,1}$, $b_{14,1}$, $b_{15,1}$, $b_{16,1}$, $b_{17,1}$, and $b_{19,1}$ were all zero. Thus, the corresponding a_{ij}'s were assigned the value zero.

When all b_{ij} values were divided by X_j, the total real output of sector j, the complete input-output coefficient matrix, A, was constructed. When the input-output coefficient matrix was subtracted from the identity matrix, the matrix of technological coefficients, I-A, was generated. The technological coefficient matrix and the final demand vector of the model are provided in Appendix [A].

The study which generated the elements of the B matrix also generated the total real output vector for the twenty

Table VI

The Total Real Output Vector, X

Row	Sector	Output
1	NSC - SAN DIEGO	1057143.00 REQUISITIONS
2	LBEACH NAVAL SHIPYARD	794165.00 MAN-DAYS
3	INTER. MAINT. ACTIVITY	2887755.00 MAN-HOURS
4	NAVAIR REWORK FACILITY	6478878.00 MAN-HOURS
5	PUBLIC WORKS CENTER	194661.00 MAN-HOURS
6	PWC - MAINTENANCE	1074960.00 MAN-HOURS
7	PWC - TRANSPORTATION	609420.00 GALLONS
8	PWC - UTILITIES ENERGY	3751626.00 MILLION BTUS
9	NAVREGMEDCEN - ADMISS.	289142.00 ADMISSIONS
10	NAVREGMEDCEN - OUTPAT.	498157.00 OUTPATIENTS
11	NAVSTA - MILITARY PERS.	45684.00 PERSONNEL ACTIONS
12	NAVSTA - PORT SERVICES	9886.00 PORT SERVICE HOURS
13	NAS MIRAMAR - AIR OPS	109434.00 AIR OPERATIONS
14	NAS MIRAMAR - AIMD	1499711.00 MAN-HOURS
15	NAS MIRAMAR - SUPPLY	572336.00 REQUISITIONS
16	NTC - RECTRACEN	5530.00 STUDENTS
17	NTC - SERSCCLCCM	4716.00 STUDENTS
18	MANPOWER - ACTIVE DUTY	75904.00 PERSONNEL
19	MANPOWER - DEPS OF ACDU	17856.00 PERSONNEL
20	MANPOWER - CIVILIAN	28209.00 PERSONNEL

sectors of the model. It is noteworthy that the row sums of the B matrix did not equal the corresponding elements of the total real output vector. This was because the twenty sectors of the model were those of selected shore-based activities only and the total real output vector contained requirements for the remaining shore-based activities and operating fleet units as well.

Using the technological coefficient matrix described above and the final demand vector, the solution to the model was found by solving

$$(I - A)\ \overline{X} = \overline{d}.$$

This yielded a baseline output level, the output level without parametric changes being made to the input-output coefficient matrix. This was a twenty element vector with the elements of the vector being the corresponding outputs of the sectors of the model. This baseline output level is presented as Table VII.

In this section of the thesis, the reader has been given the formulation of "A Regional Input-Output Model For Forecasting Shore-Based Navy Workload" in the 11 Naval District and its component parts. The elements of the input matrix, B, and their origin have been explained. The elements of the input-output coefficient matrix, A, and their computation have been explained. The technological coefficient matrix,

Table VII

Baseline Output Levels

Row	Sector	Output Level
1	NSC - SAN DIEGO	1572270.00 Requisitions
2	LBEACH NAVAL SHIPYARD	794165.00 Man-Days
3	INTER. MAINT. ACTIVITIES	2957636.00 Man-Hours
4	NAVAIR REWORK FACILITY	6478878.00 Man-Hours
5	PUBLIC WORKS CENTER	2589904.00 Man-Hours
6	PWC--MAINTENANCE	1573271.00 Man-Hours
7	PWC--TRANSPORTATION	1503492.00 Gallons of Fuel
8	PWC--UTILITIES ENERGY	5939721.00 Million BUT's
9	NAVREGMEDCEN--ADMISSIONS	310200.00 Admissions
10	NAVREGMEDCEN--OUTPATIENTS	1726666.00 Outpatients
11	NAVSTA--MILITARY PERSONNEL ACTIONS	45684.00 Personnel Actions
12	NAVSTA--PORT SERVICES	9886.00 Port Service Hours
13	NAS MIRAMAR--AIR OPERATIONS	109434.00 Air Operations
14	NAS MIRAMAR--AIMD	1602596.00 Man-Hours
15	NAS MIRAMAR--SUPPLY	620330.00 Requisitions
16	NTC--RECRUIT TRAINING CENTER	5530.00 Students
17	NTC--SERVICE SCHOOLS COMMAND	4716.00 Students
18	MANPOWER--ACTIVE DUTY NAVY	106825.00 Personnel
19	MANPOWER--DEPENDENTS OF ACTIVE DUTY NAVY	140704.00 Personnel
20	MANPOWER--CIVILIANS	56891.00 Personnel

I-A, has been presented and the solution to the model, the baseline output level, has been presented.

IV. METHODOLOGY USED IN THE SENSITIVITY ANALYSIS

The Navy Personnel Research and Development Center's "A Regional Input-Output Model For Forecasting Shore-Based Navy Workload" in the 11th Naval District was composed of a twenty by twenty technological coefficient matrix, I-A, and a twenty element final demand vector, $\overline{d}$. In order to perform a sensitivity analysis on this model, it was decided to parametrically change each of the sixty-three nonzero a_{ij}'s, $i = 1, 2, \ldots, 20$; $j = 1, 2, \ldots, 20$, of the input-output coefficient matrix, A, by a small percentage called delta and to compute the output of the model with the new technological coefficient matrix, (I-A*),[6] and the given final demand vector, $\overline{d}$.

The elements of the final demand vector were held constant during this process because the interest was in what would happen to the output of the model if the input-output coefficients were parametrically changed for each row of A and a solution was obtained to the model with the final demand vector being held constant.

The decision was made to change an entire row rather than to change individual elements of the input-output coefficient matrix. This was because of the manner in which the a_{ij}'s were computed, as discussed in Sections II and III of this thesis. The input-output coefficients were computed from the input

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[6] The asterisk indicates a parametric change has been effected.

matrix, B. The elements of B were taken from studies of each sector of the model, and thus, an entire row of B was the result of one study. Any one column of B was the partial result of twenty such studies. It was more likely that if over-counting or under-counting was done in the sorting of a sector's data to get the input for each sector, the difference would be more prevalent in the row than in the column corresponding to the sector under study. Since the input matrix, B, reflected this difference in its rows, it then followed that the a_{ij}'s, computed from the b_{ij}'s, would preserve this property. From the relationship between a_{ij} and b_{ij}, given in Section I, it could be seen that parametrizing a row of the input-output coefficient matrix, A, by α percent was equivalent to parametrizing the same row of the input matrix, B, by α percent. That is, since

$$a_{ij} = b_{ij}/\text{total real output of industry } j,$$

if

$$\hat{b}_{ij} = \alpha\, b_{ij},$$

then

$$\hat{a}_{ij} = \alpha\, a_{ij}$$

as long as the total real output of industry j is not changed.

Further, it was found, on inspection and testing, that parametrization of rows produced consistently larger changes than did parametrization of columns. Thus, it was decided to concentrate on the effect that parametric changes to the rows would make and not to concentrate on the effect that parametric changes to the columns would make.

In Section III, Table VII, the baseline output level, Q, of the model was presented. Q was a twenty element vector with each element of the vector representing one of the twenty sectors of the Navy Personnel Research and Development Center's model. To compute output levels of the model with parametric changes effected to the A matrix, each row of the input-output coefficient matrix was parametrically changed by a percentage, one row at a time, and a new output level, Q^i, was obtained. One Q^i for each row of the input-output coefficient matrix was calculated for each delta. The elements of Q^i represented output levels for each sector of the parametrized model.

To calculate the percentage change in output level for each of the twenty sectors, the baseline output level of that sector was subtracted from that sector's element in Q^i, the difference divided by the baseline output level of that sector, and the result multiplied by 100. The following algebraic expression was utilized to compute the percentage changes:

$$\frac{Q_j^i - Q_j}{Q_j} \times 100 = \text{percentage change}$$

in the output of the j^{th} sector of the model when the i^{th} row of the input-output coefficient matrix had been parametrized; i = 1, 2, ... , 20; j = 1, 2, ... , 20. Using this expression, twenty percentage changes were computed for each parametrized row.

It was necessary to decide which of these, if any, were significant enough to use for later analysis. To do this, a test-statistic had to be decided upon. It was noted that most percentage changes tended to be at or near zero. It was decided to use the mean percentage change as the test-statistic. The mean percentage change for the output of the model, given a parametrized row, was computed. This mean percentage change was considered significant for the delta value used to compute the output of theparametrized model. Each percentage change, of the twenty computed above, was then compared to this test-statistic and if it was greater than the test-statistic, it was considered significant. The significant percentage changes were identified and used to further inspect the inter-sectorial relationships in the next section of this thesis. If the percentage change was less than the test-statistic, it was considered not significant and disregarded.

As an example of this methodology, significant percentage changes in the output level of the model with row nine, the row corresponding to Naval Regional Medical Center--Admissions, being changed by ten percent will now be given. Table VIII is the vector of percentage changes for the model when row nine

Table VIII

Vector of Percentage Changes in Outputs for a Parametric Change in Row Nine of Ten Percent

Sectors 1- 5	0.06	0.0	0.0	0.0	0.03
Sectors 6-10	0.02	0.02	0.06	0.69	0.11
Sectors 11-15	0.0	0.0	0.0	0.0	0.0
Sectors 16-20	0.0	0.0	0.16	0.14	0.13

Read across the rows; values in percent.
The mean percentage change equals 0.07 percent.

of the input-output coefficient matrix was parametrized by ten percent. This vector was written as Q_j^9, j = 1, 2, ... , 20.

The significant percentage changes are those greater than the mean percentage change. Sequentially going through the table, the significant percentage changes are: sector nine, 0.69 percent; sector ten, 0.11 percent; sector eighteen, 0.16 percent; sector nineteen, 0.14 percent; and sector twenty, 0.13 percent.

Interpretation of these percentage changes is now easily done. If the actual input-output coefficients for the Naval Regional Medical Center--Admissions, sector nine, were ten percent larger than the estimates, one could expect the output levels for each of the sectors to be the given percentages greater than the baseline output levels. For example, the output for Manpower--Civilian, sector twenty, would be 56964

or 0.13 percent greater than the 56891 personnel indicated by the baseline output level.

The methodology employed in this sensitivity analysis was such that a minus delta implied an over-estimation of the input-output coefficients by the given percentages and a positive delta implied an under-estimation of the input-output coefficients. It was reasonable to assume that, in the worst case, delta should be in the range -10 percent to +10 percent.[7] Thus, the computed percentage changes given in Section V of this thesis were for various values of delta in the range -25 percent to +25 percent. This wide range encompassed the reasonable range and allowed for a wider range over which to do the analysis.

Depending by how much a particular row of the input-output coefficient matrix was likely to be over-estimated or under-estimated, lower or upper bounds on the percentage change in the output level of the Navy Personnel Research and Development Center's model were established. Decreasing the coefficients of a row by ten percent and solving the model would yield an output level for each of the twenty sectors. Similarly, increasing the coefficients of that same row by ten percent would yield another output level for each sector. The percentage changes computed for each sector would then be bounds on the

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[7]These values were arrived at in consultation with Mr. Thomas Blanco of the Navy Personnel Research and Development Center who did much of the estimation of the input-output coefficients.

percentage changes of the respective sectors. As an example, the coefficients of row nine, the row corresponding to the Naval Regional Medical Center--Admissions, were decreased by ten percent and percentage changes in the output levels of the twenty sectors were calculated. The percentage change for sector nine was -0.69 percent. When the coefficients were increased by ten percent the percentage change for sector nine was 0.69 percent. These two percentage changes were lower and upper bounds on the percentage change for sector nine for any values used for parametrization between plus and minus ten percent. Decreasing the input-output coefficients of row nine by five percent caused a percentage change of -0.34 percent and increasing the coefficients of row nine caused a percentage change of 0.34 percent. Both of these percentage changes were bounded by -0.69 percent and 0.69 percent. Therefore, as long as the change in the input-output coefficients for row nine was within plus and minus ten percent, the resultant percentage change in the output of sector nine would be bound by plus and minus 0.69 percent. Further, the bounds computed for the parametrized sector were also bounds on the percentage change for all other sectors of the model.

V. RESULTS OF THE PARAMETRIC SENSITIVITY ANALYSIS

In order to conduct a parametric sensitivity analysis, a computer algorithm was written following the methodology outlined above in Section IV. First, the algorithm computed the baseline output level, the solution to the Navy Personnel Research and Development Center's Regional Input-Output Model without parametrically changing the rows of the input-output coefficient matrix. Next, each row of the input-output coefficient matrix was parametrically changed by a percentage and a new output level was calculated. This gave twenty new output levels, one for each of the twenty sectors of the model. Delta values of -25 percent to +25 percent were used in +5 percent increments. Thus, a total of ten values were used for parametrically changing each row of the input-output coefficient matrix. This provided ten output levels for each sector to be compared with the baseline output level of that sector. The comparison was done by computing the percentage change from the sectors baseline output level and identifying the significant percentage changes.

Certain sectors of the model, by the definition of significant percentage change given in Section IV, caused more significant percentage changes than others. Since the requirement for manpower was a primary concern of the Navy Personnel Research and Development Center's model, particular attention was given to sectors which when their input-output coefficient

row was changed caused significant percentage changes and to all manpower sectors. This group included Naval Supply Center--San Diego, sector one; San Diego-based Intermediate Maintenance Activities, sector three; Public Works Center, sector five; PWC--Maintenance, sector six; PWC--Transportation, sector seven; PWC--Utilities, sector eight; Naval Regional Medical Center--Admissions, sector nine; Naval Regional Medical Center--Outpatients, sector ten; NAS Miramar--AIMD, sector fourteen; NAS Miramar--Supply, sector fifteen; Manpower--Active Duty Navy, sector eighteen; Manpower--Dependents of Active Duty Navy, sector nineteen; and Manpower--Civilian, sector twenty. A summary of the significant percentage changes caused by parametrizing a row of the input-output coefficient matrix corresponding to a particular sector is given as Table IX.

The sectors that had no significant percentage changes were ones whose row of the input-output coefficient matrix consisted of all zeros. This meant that these sectors had no input from the other sectors of the model. Thus, their rows of the input matrix were all zero. Since the input matrix rows and the input-output coefficient matrix rows were all zero, on parametrization the coefficients remained zero. Solution of the parametrized model then gave the same output levels as the baseline output level and thus no significant percentage changes were computed. The outputs of these sectors were always constant.

Line numbering on the figures of this section was done to indicate the sector the line corresponded to. The lines were

Table IX

Summary of Significant Percentage Changes Caused by Parametrizing a Particular Sector

Sector Parametrized		Sectors with Significant Percentage Changes
1	NAVAL SUPPLY CENTER	1, 7
2	LBEACH NAVAL SHIPYARD	None
3	INTER. MAINT. ACTIVITIES	1, 3
4	NAVAIR REWORK FACILITY	None
5	PUBLIC WORKS CENTER	5, 7
6	PWC--MAINTENANCE	5, 6, 7
7	PWC--TRANSPORTATION	5, 7
8	PWC--UTILITIES ENERGY	5, 8
9	NAVREGMEDCEN--ADMISSIONS	9, 10, 18, 19, 20
10	NAVREGMEDCEN--OUTPATIENTS	10
11	NAVSTA--MILITARY PERSONNEL	None
12	NAVSTA--PORT SERVICES	None
13	NAS MIRAMAR--AIR OPS	None
14	NAS MIRAMAR--AIMD	14, 15
15	NAS MIRAMAR--SUPPLY	15
16	NTC--RECTRACEN	None
17	NTC--SERSCOLCOM	None
18	MANPOWER--ACTIVE DUTY NAVY	10, 18, 19
19	MANPOWER--DEPENDENTS OF ACDU	10, 19
20	MANPOWER--CIVILIAN	20

provided so the reader could have a visual representation of the percentage change computed for a known value by which the input-output coefficient matrix row for the sector in the figure heading was changed. Further, to visualize the bounds, the reader may select a percentage change for a sector of concern.

The bound will be the ordinate of the least-squares line at the point on the line corresponding to the chosen percentage change.

The least-squares lines on some figures were very flat, indicating small slopes. This meant that the percentage changes resulting from changes in the values of the rows of the input-output coefficient matrix were very small. Some of these "flat" lines may seem uninteresting to the reader but they were included for the many managers who may read this thesis. A quick look at a graph is sometimes easier to understand than to have to compute values and do the graphing for one's self.

The coefficient of determination, r^2, was computed to establish how well the delta values and their associated percentage changes for a significant sector fit the linear regression. AT r^2 equal zero, you have no fit and at r^2 equal one, you have a perfect fit. In the case of all sectors which showed a significant percentage change, r^2 was approximately equal to one. The r^2 values were in all cases greater than 0.9995. Thus, the percentage changes computed for the given delta values were very close to being linear. Since the model was linear and the parametric changes formed linear transformations of the input-output coefficient rows, the resultant percentage changes, computed from the sectorial outputs, would themselves be expected to be linear. It was felt that the reason the regression line did not pass exactly through the origin was because of round-off by the computer in calculating

the inverse of the twenty technological matrices, I-A*. Some of the percentage changes were not considered to be significant and so the regression lines for their sectors were not graphed. Nonetheless, the reader might be interested in the magnitude of the nonsignificant percentage changes so all percentage changes resulting from parametrization of a model sector are given in Appendix [B]. The reader may check this appendix for any sector of concern.

A. NAVAL SUPPLY CENTER

In terms of significant percentage changes, for all delta values used in the sensitivity analysis, parametric changes to the input-output coefficients of sector one, Naval Supply Center--San Diego, produced significant changes in the output levels of Navl Supply Center, sector one, and PWC--Transportation, sector seven. This could be reasoned out since in order for the Naval Supply Center to serve the other sectors, supply them with goods, the Naval Supply Center must have transportation to transport goods from the supply depot to the requisitioning activity. Thus, the significant change in the output level of PWC--Transportation, given the change in the Naval Supply Center's output was expected. Other sectors showed change as well, but based on the definition of "significant percentage change," the sectors of concern were the Naval Supply Center and PWC--Transportation. The significant percentage changes that occurred as a result of parametrizing row

one of the input-output coefficient matrix are graphed as Figure 3.

B. INTERMEDIATE MAINTENANCE ACTIVITIES

Parametric changes to the nonzero elements of the input-output coefficients in row three, the row corresponding to San Diego-based Intermediate Maintenance Activities, produced significant changes in the output levels of Naval Supply Center--San Diego, sector one, and San Diego-based Intermediate Maintenance Activities. Knowing that the Intermediate Maintenance Activities were heavily dependent on the Naval Supply Center to supply repair parts for maintenance, this linkage was to be expected. The significant percentage changes that resulted from parametrizing row three are graphed as Figure 4.

C. PUBLIC WORKS CENTER

Changing the nonzero elements of row five of the input-output coefficient matrix, the row representing the Public Works Center, sector five, produced significant changes in the output levels of Public Works Center, sector five, and PWC--Transportation, sector seven. Most of the output for the Public Works Center required transportation of some sort to expend the man-hours so the change in the output level of PWC--Transportation was to be expected. One would also expect changes in the output levels of the sectors which supported the Public Works Center, i.e., Naval Supply Center--San Diego, PWC--Utilities, Manpower--Civilian, and as expected, changes occurred. However, by the definition of "significant," these

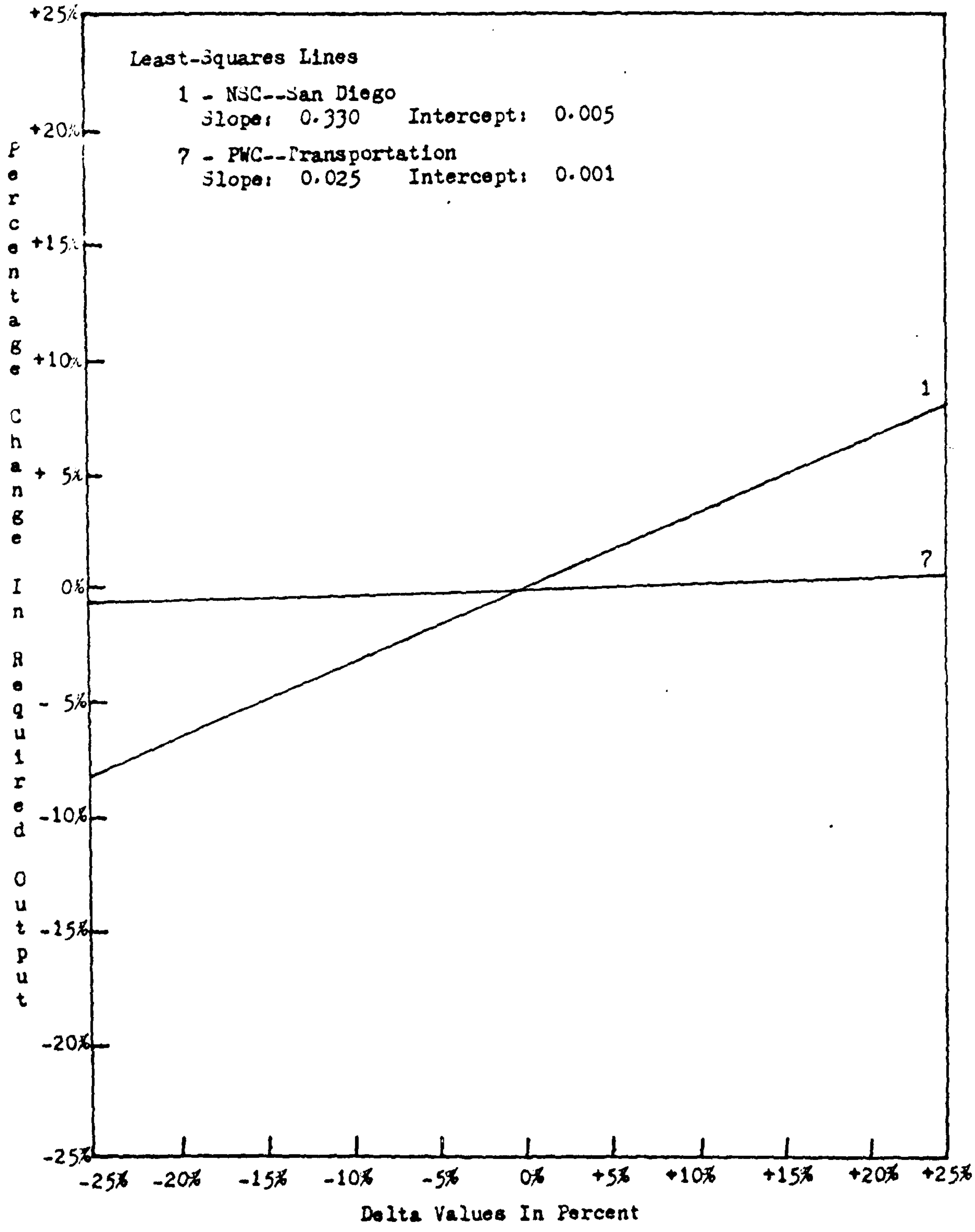

Figure 3. NSC--San Diego, Sector 1.

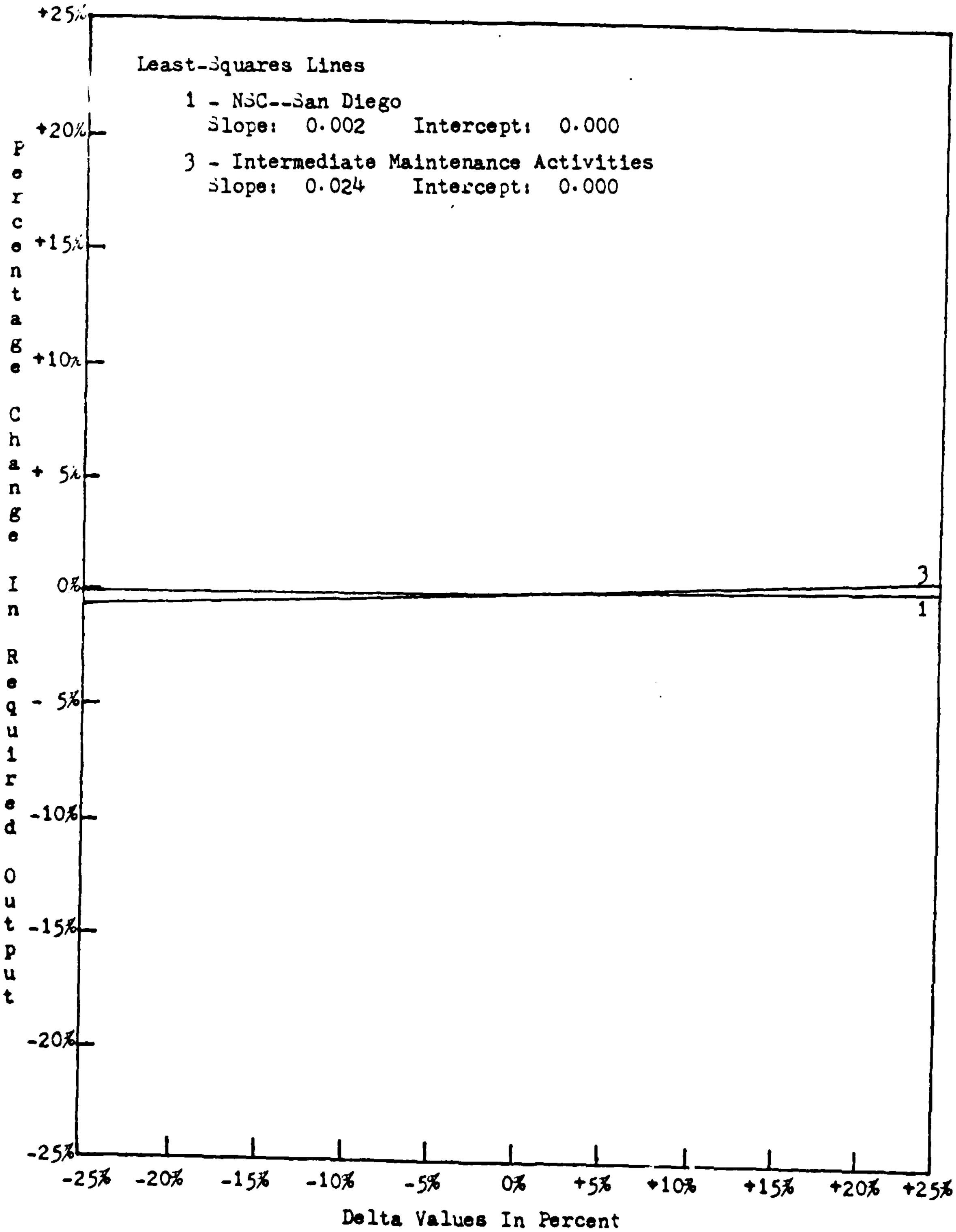

Figure 4. Intermediate Maintenance Activities, Sector 3.

changes were not significant. It was also noted that the percentage change in output of the Public Works Center was approximately proportional to the amount of change made to the input-output coefficients of that sector. Figure 5 is a graph of the significant percentage changes resulting from parametrizing row five.

D. PWC--MAINTENANCE

Parametrically changing the nonzero elements of row six of the input-output coefficient matrix, the row corresponding to PWC--Maintenance, sector six, produced significant changes in the output levels of Public Works Center, sector five, PWC--Maintenance, sector six, and PWC--Transportation, sector seven. Since the model was originally formulated with all PWC sectors combined into the one sector, Public Works Center, the change in the output level of the Public Works Center was expected. Since maintenance was required to keep the fiscal plants of the Public Works Center up, the change in the output level of sector six, PWC--Maintenance, was expected. The change in PWC--Transportation was expected also since transportation was required to transport personnel and equipment to maintenance tasks in the 11th Naval District. Figure 6 is the graph of significant percentage changes caused by parametrizing row six.

E. PWC--TRANSPORTATION

Changing the elements of row seven, the row corresponding to sector seven, PWC--Transportation, evidenced significant

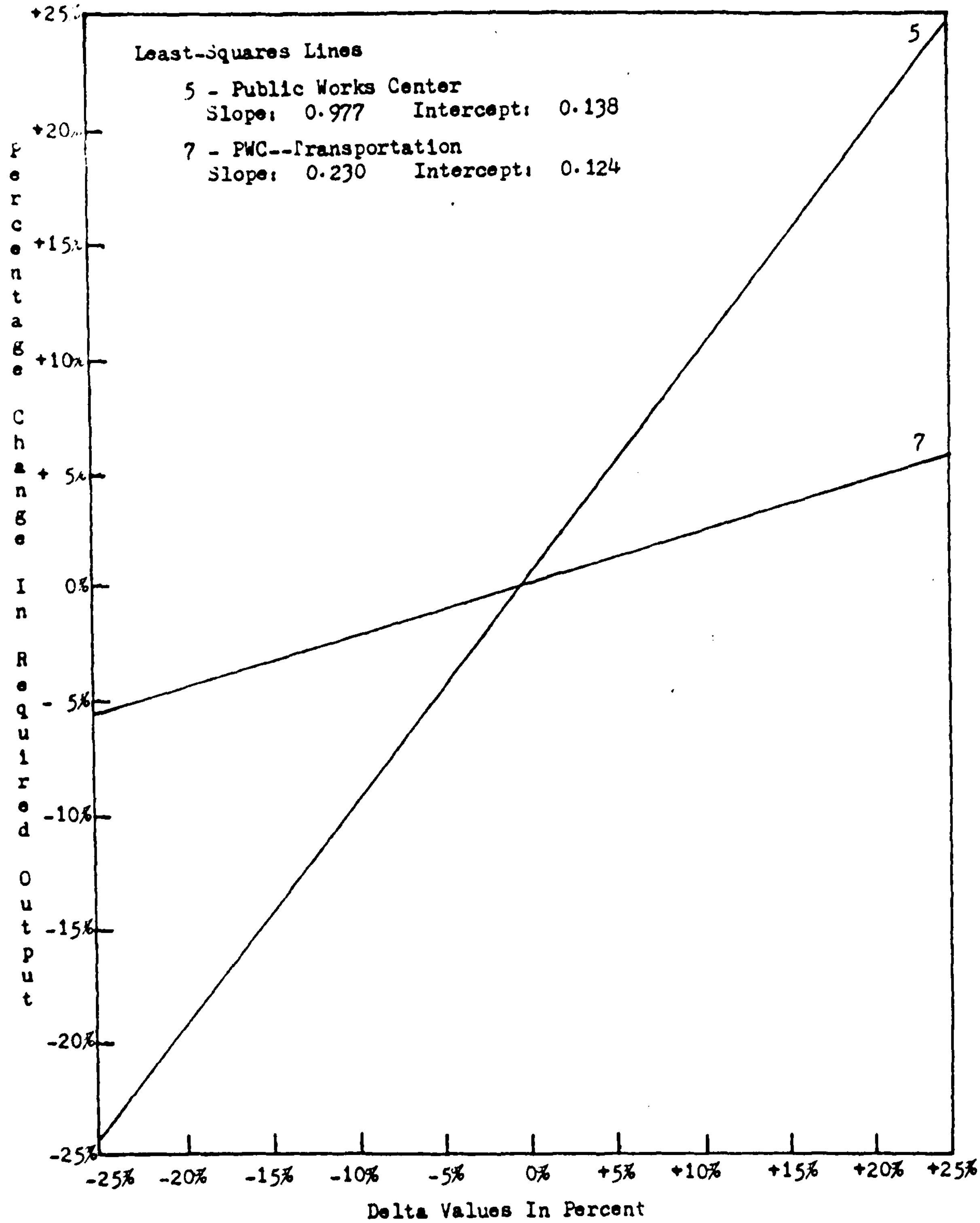

Figure 5. Public Works Center, Sector 5.

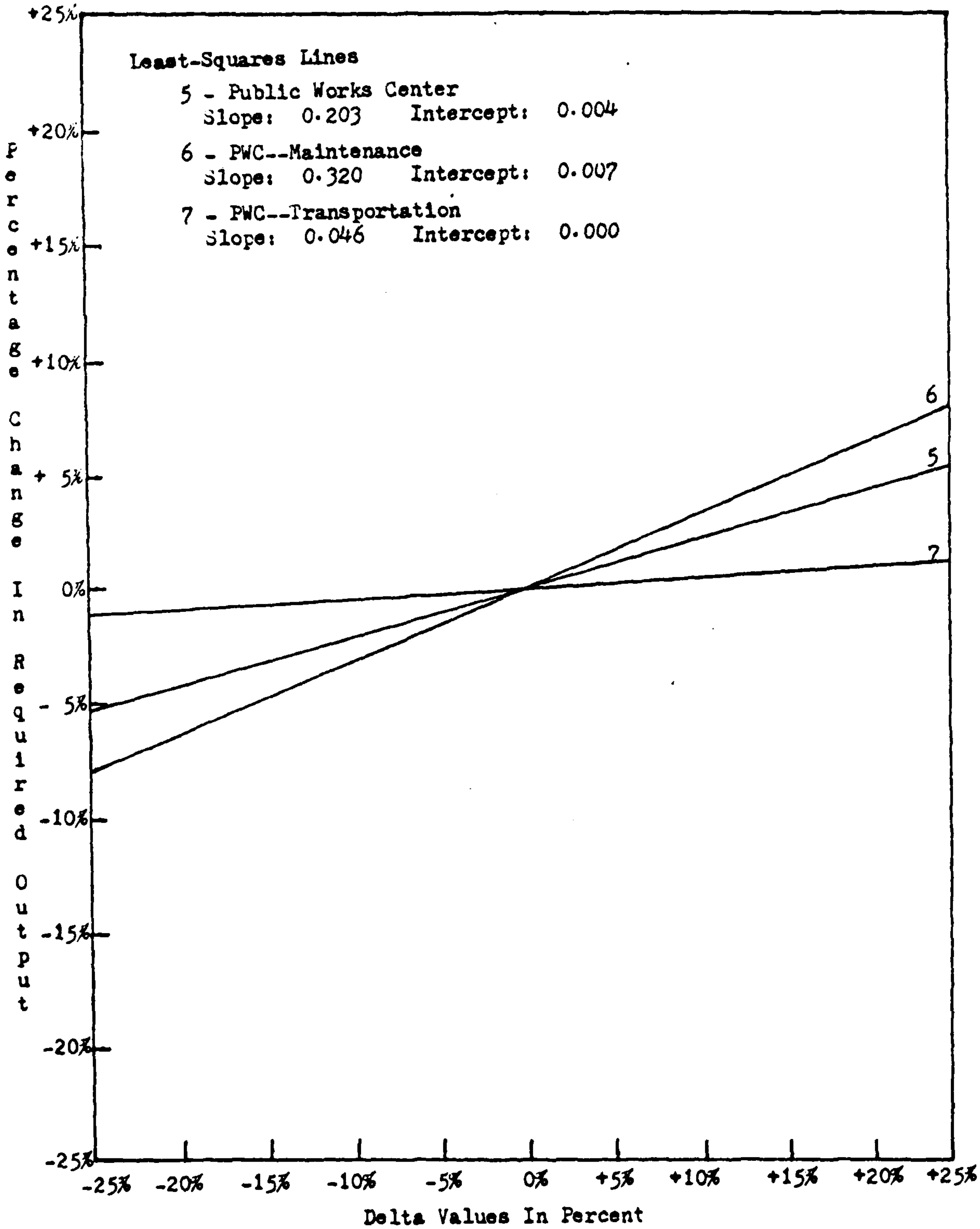

Figure 6. PWC--Maintenance, Sector 6.

changes in the output levels of Public Works Center, sector five, and PWC--Transportation, sector seven. Inasmuch as the relationship between all sectors of the Public Works Center, as explained above, existed, these changes were expected. The graph of the significant percentage changes resulting from parametrizing row seven is presented as Figure 7.

F. PWC--UTILITIES

Changing row eight, the row corresponding to PWC--Utilities, sector eight, caused significant changes to Public Works Center, sector five, and PWC--Utilities, sector eight. As explained above, the relationship of all Public Works Center sectors would lead one to expect these changes. The graph of these significant percentage changes is given as Figure 8.

G. NAVREGMEDCEN--ADMISSIONS

The sector whose input-output coefficient row, when changed, caused the greatest number of significant percentage changes was the Naval Regional Medical Center--Admissions, sector nine. Changing the nonzero elements of row nine produced significant changes in the output levels of Naval Regional Medical Center--Admissions, Naval Regional Medical Center--Outpatients, Manpower--Active Duty Navy, Manpower--Dependents of Active Duty Navy, and Manpower--Civilian. The change in the output level of Naval Regional Medical Center--Admissions was to be expected since the input-output coefficients in that row were changed. A change in the number of personnel admitted

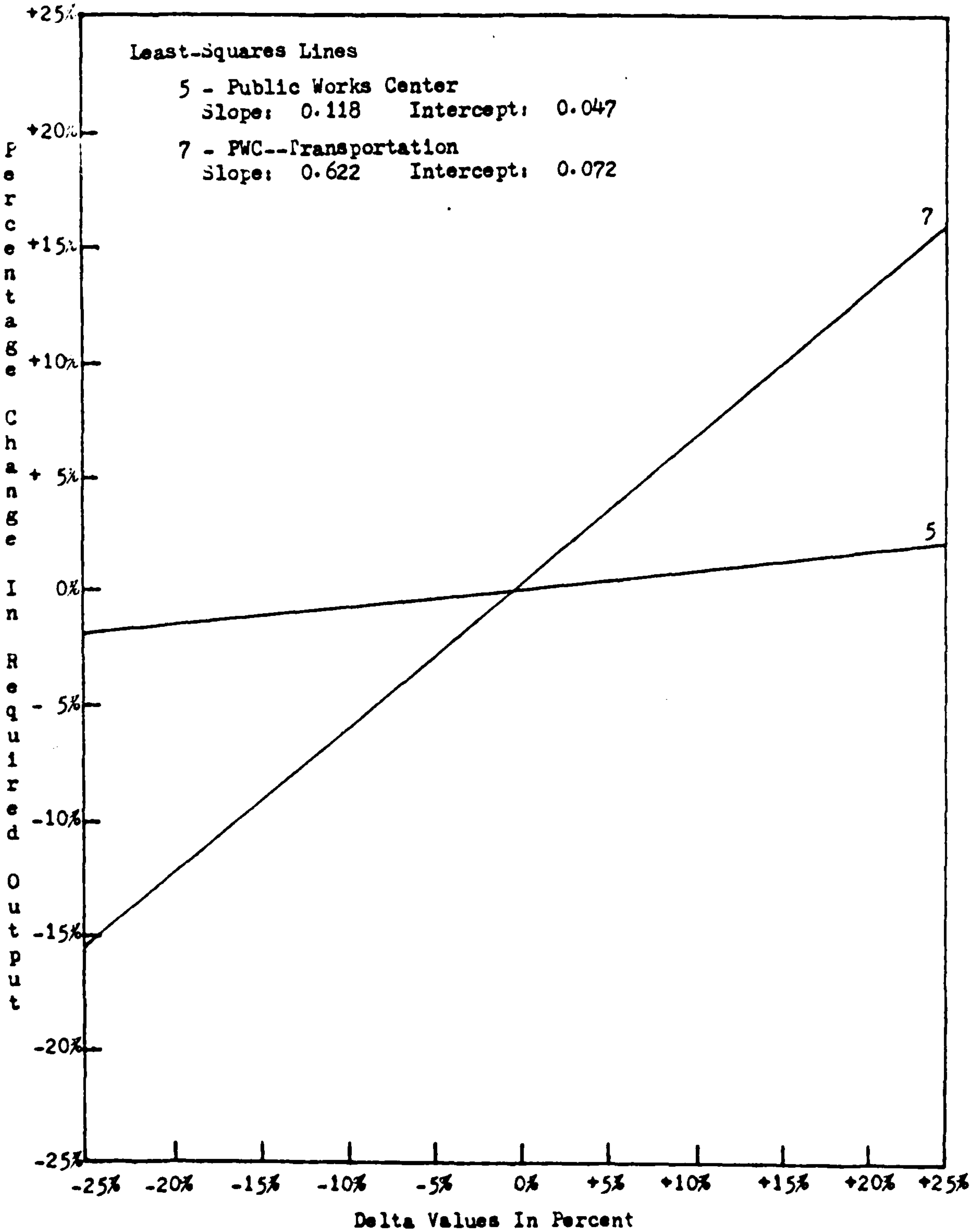

Figure 7. PWC--Transportation, Sector 7.

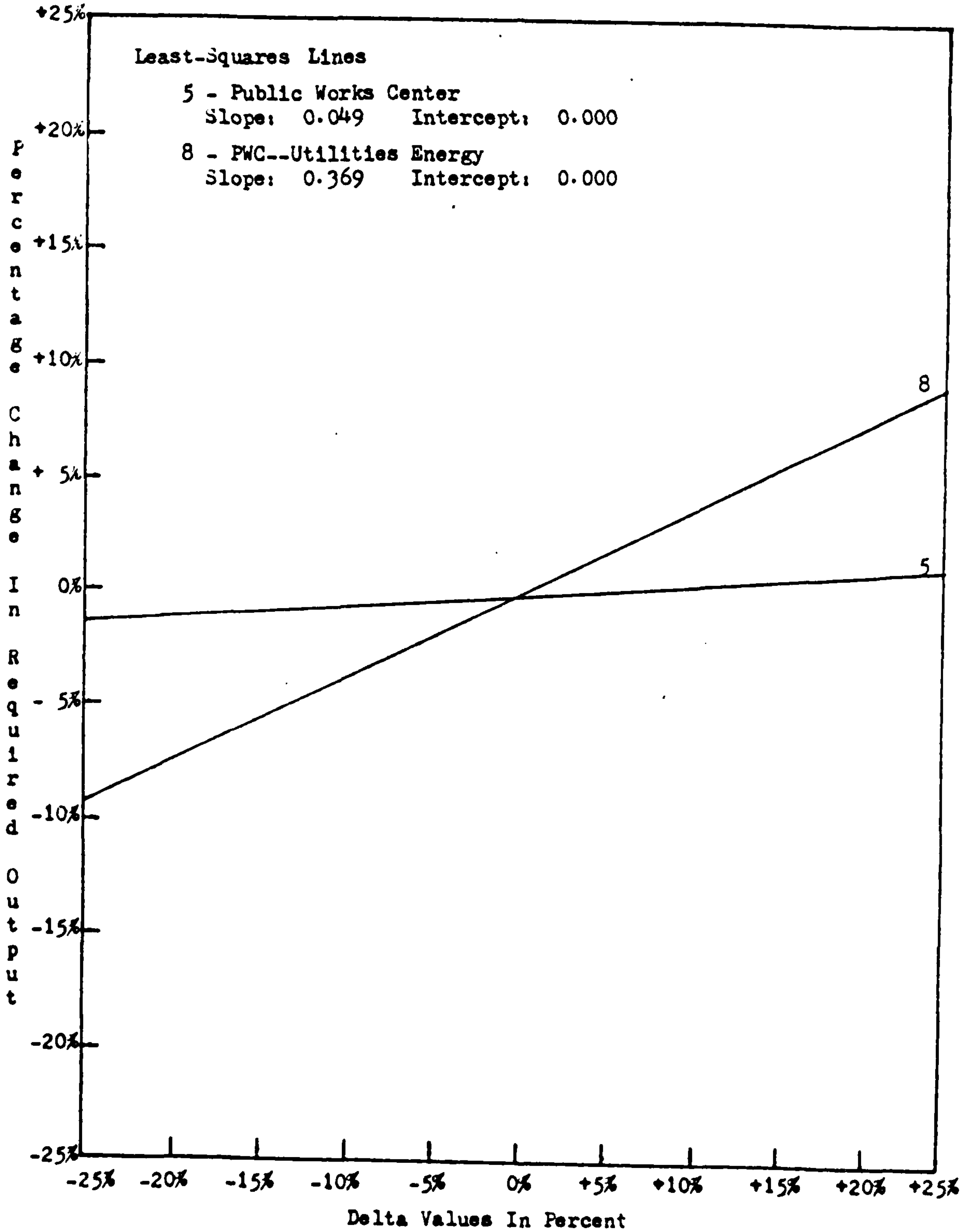

Figure 8. PWC--Utilities Energy, Sector 8.

to the Naval Regional Medical Center would generally cause a change in the number of outpatient visits and so a change in outpatient visits was to be expected. Given that active duty personnel and dependents of active duty personnel comprise a large part of the number of patients who are seen at the hospital, change in the output of the sectors corresponding to these two groups of people, sectors eighteen and nineteen respectively, was expected. Civilians make up a large part of the staff at the Naval Regional Medical Center and so change in the workload at the hospital would precipitate a change in the civilian workforce at the hospital. These significant percentage changes are given as the graph of Figure 9.

H. NAVREGMEDCEN--OUTPATIENTS

Changing row ten of the input-output coefficient matrix, the row which corresponded to Naval Regional Medical Center--Outpatients, sector ten, showed only a change in the output of that sector. The Naval Regional Medical Center was originally only one sector in the model and so it was assumed that change in the output level of the related sector was absorbed in the Naval Regional Medical Center--Admissions sector, sector nine. Figure 10 is the graph of significant percentage changes.

I. NAS MIRAMAR--AIMD

Changing row fourteen, the row corresponding to NAS Miramar--AIMD, sector fourteen, produced significant changes in the outputs of NAS Miramar--AIMD, sector fourteen, and NAS

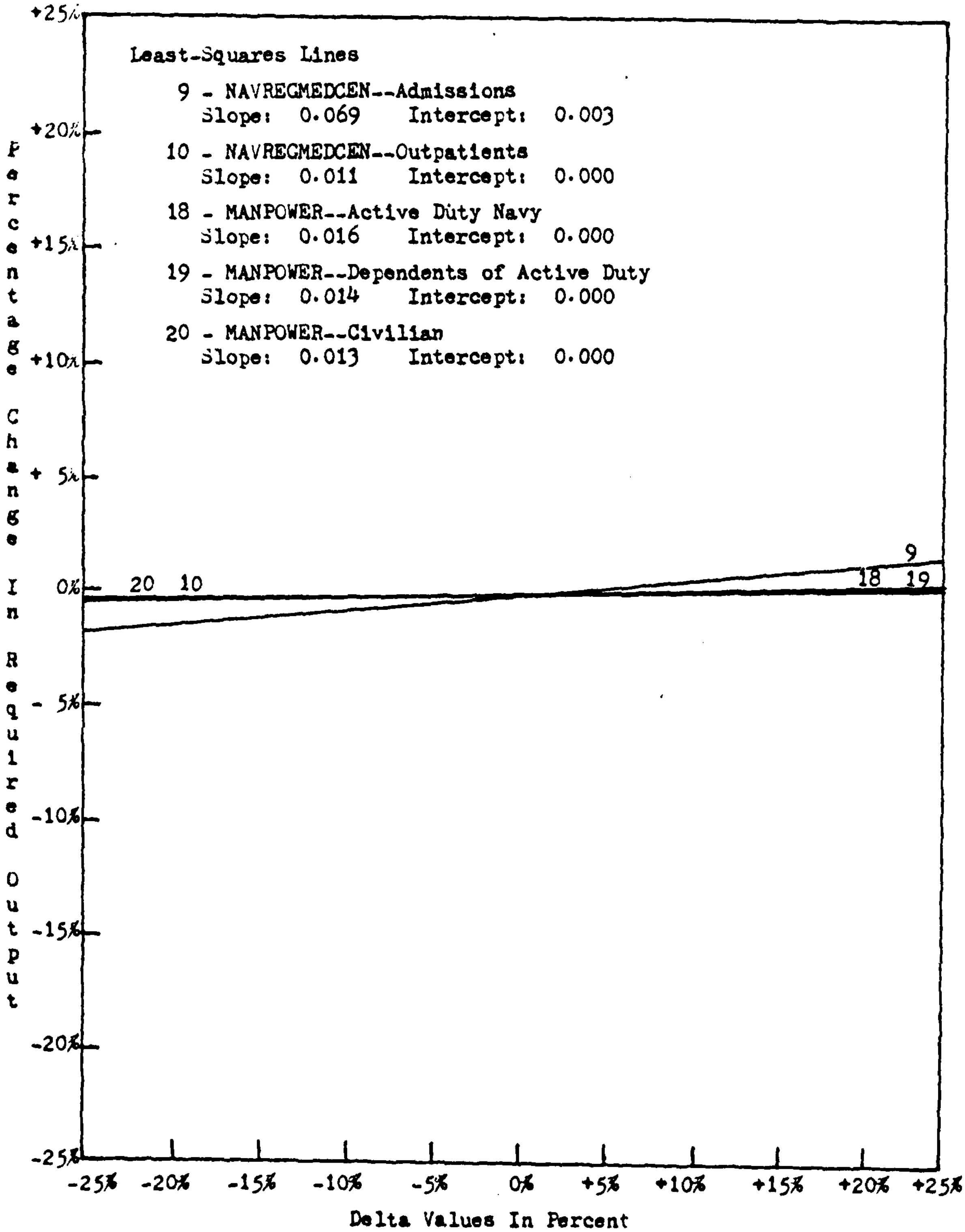

Figure 9. NAVREGMEDCEN--Admissions, Sector 9.

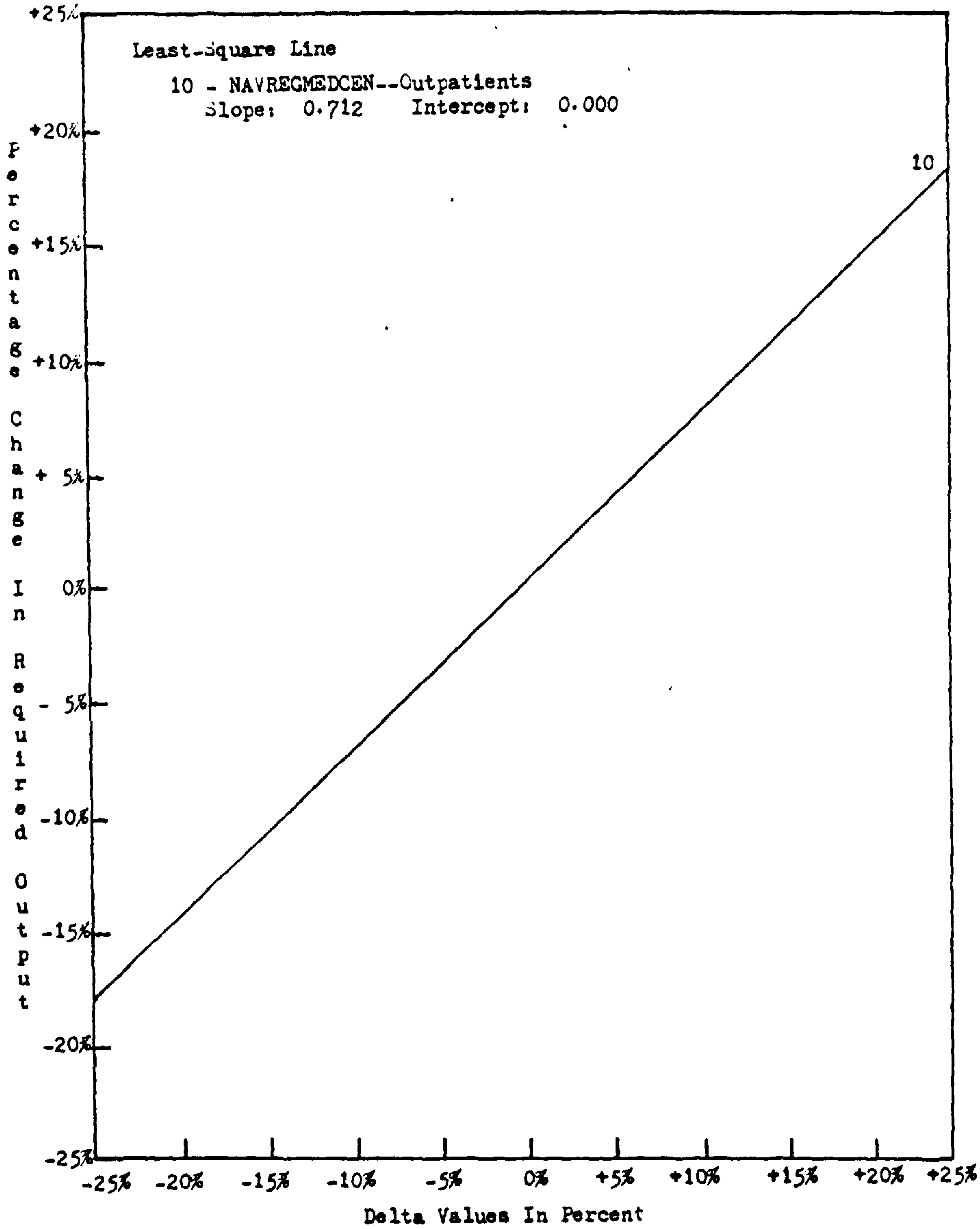

Figure 10. NAVREGMEDCEN--Outpatients, Sector 10.

Miramar--Supply, sector fifteen. This was to be expected since the Aircraft Intermediate Maintenance Depot is heavily dependent on NAS Miramar--Supply for repair parts to effect repairs to aircraft. See Figure 11 for a graph of the significant percentage changes.

J. NAS MIRAMAR--SUPPLY

Changing row fifteen, the row corresponding to NAS Miramar--Supply, sector fifteen, produced significant change in the output level of NAS Miramar--Supply, sector fifteen, only. This was to be expected since all requisitions from NAS Miramar were processed by NSC as NAS Miramar--Air Operations, requisitions. The percentage changes ranged from -1.94 percent for a delta value of -25 percent to +1.94 percent for a delta value of +25 percent. Since the sector under study was the only sector to show significant percentage change, no graph is provided.

K. MANPOWER--ACTIVE DUTY NAVY

Parametrically changing the nonzero elements of row eighteen, the row corresponding to Manpower--Active Duty Navy, sector eighteen, produced significant percentage changes in the output levels of Naval Regional Medical Center--Outpatients, sector ten, Manpower--Active Duty Navy, sector eighteen, and Manpower--Dependents of Active Duty Navy, sector nineteen. Changing the number of active duty personnel in the 11th Naval District should cause a change in the number of dependents of active duty personnel. With a change in the number of active

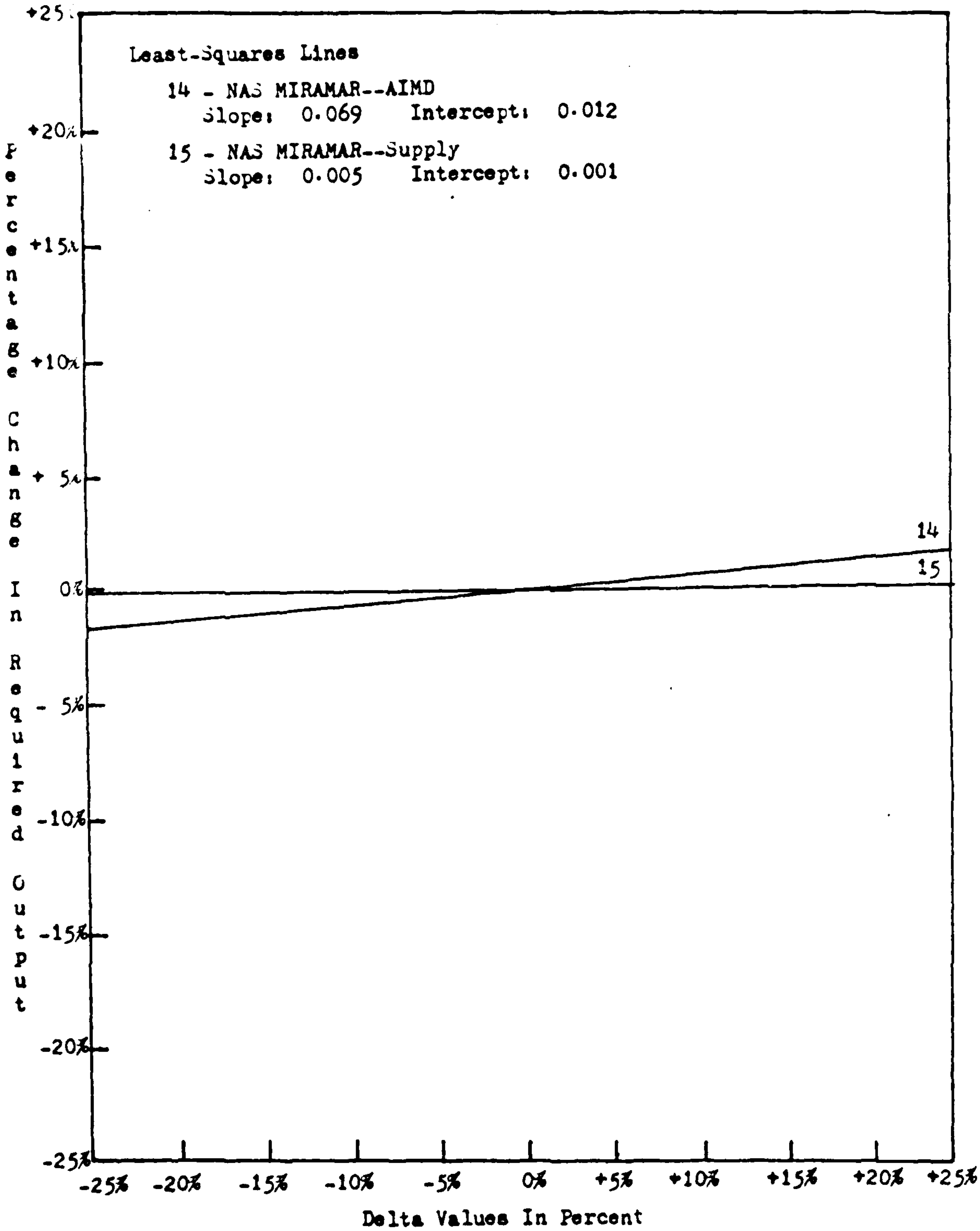

Figure 11. NAS MIRAMAR--AIMD, Sector 14.

duty personnel and a change in the number of dependents of active duty personnel in the 11th Naval District one would expect a change to occur in the number of outpatient visits at the Naval REgional Medical Center. Significant percentage changes are graphed as Figure 12.

L. MANPOWER--DEPENDENTS OF ACTIVE DUTY

Changing row nineteen, the row corresponding to Manpower--Dependents of Active Duty Navy, sector nineteen, produced significant changes in the output levels of Naval Regional Medical Center--Outpatients, sector ten, and Manpower--Dependents of Active Duty Navy, sector nineteen. This was to be expected since dependents of active duty personnel comprise a large part of the Naval Regional Medical Center's outpatient service. See Figure 13 for the graph of significant percentage changes.

M. MANPOWER--CIVILIAN

Changing row twenty of the input-output coefficient matrix, the row corresponding to Manpower--Civilian, sector twenty, produced a significant change in the output level of Manpower Civilian, sector twenty. One would expect changes to occur in the output levels of all sectors where civilian manpower was utilized but the model only showed a change of any kind in the output for Manpower--Civilian. Figure 14 is the graph of this significant percentage change.

As discussed above, upper and lower bounds may be taken from the graphs. Choose the plus and minus percentages a row is most likely to be off by. Then construct the necessary

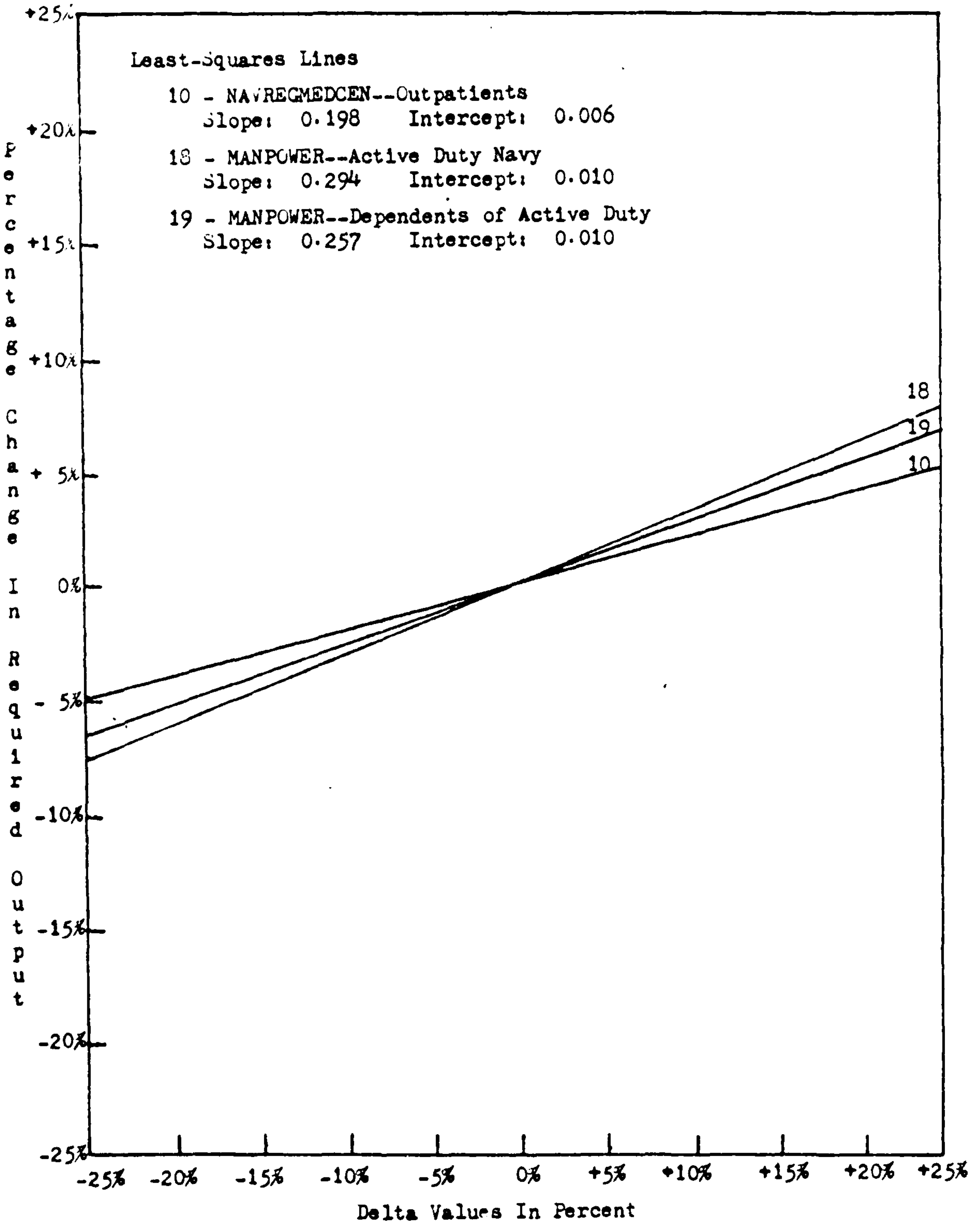

Figure 12. MANPOWER--Active Duty Navy, Sector 18.

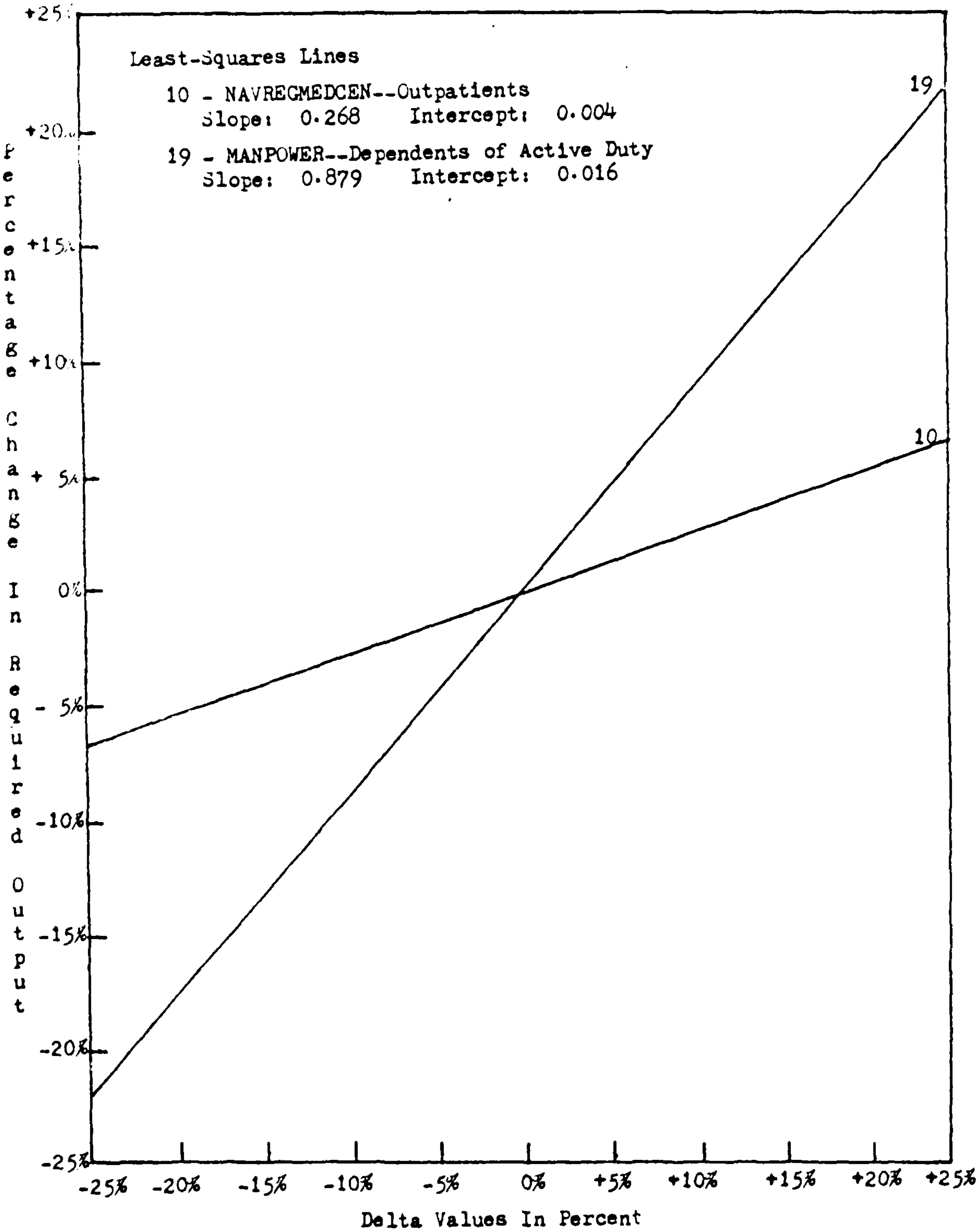

Figure 13. MANPOWER--Dependents of Active Duty, Sector 19.

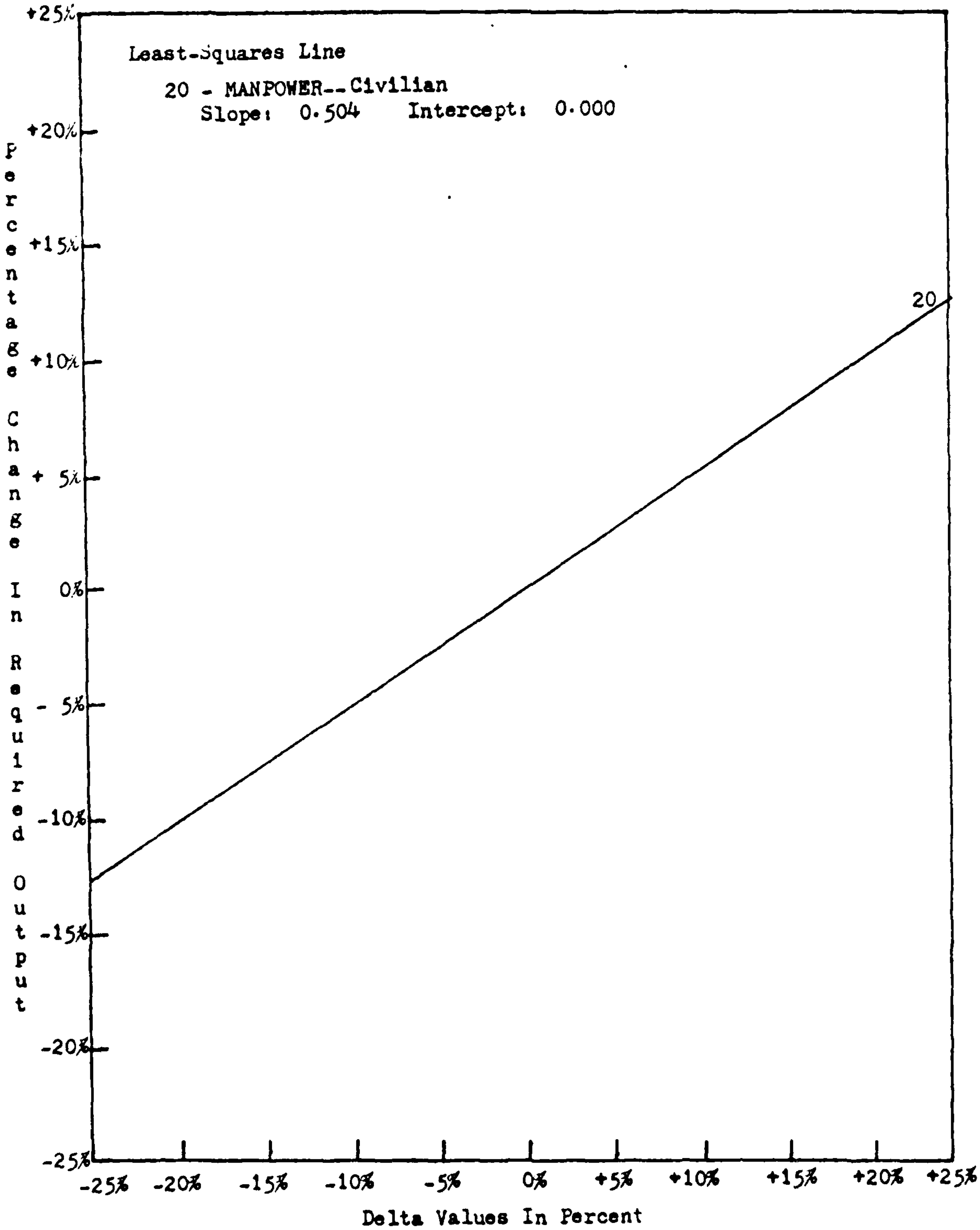

Figure 14. MANPOWER--Civilian, Sector 20.

perpendiculars from the chosen values to the least-squares line of the sector of interest. From the points of intersection on the least-squares line to the ordinate axis of the graph construct other perpendiculars. Where the normal lines intersect the ordinate axis, bounds may be read.

VI. SUMMARY

A. CONCLUSIONS

This section presents the conclusions resulting from the parametric sensitivity analysis.

The most sensitive sector to parametric change of its input-output coefficients was the Public Works Center. When its input-output coefficient row, row five, was parametrized and percentage changes were computed for the various values of delta, this sector had a least-squares line with a slope of 0.98. This implied that if row five, the row of the A matrix corresponding to the Public Works Center was parametrized, the percentage change in the output of that sector would be approximately equal to the percentage used for parametrization. Coupled with this was the percentage change of PWC--Transportation. The slope of the least-squares line for PWC--Transportation, sector seven, was 0.23. This implied that if the row of the input-output coefficient matrix representing the Public Works center were changed by a small amount then the output level of PWC--Transportation would be approximately that of the baseline output level of PWC--Transportation plus this baseline output level times 0.23 times delta. This intersectorial relationship indicated that the managers of these two sectors would want to be very mindful of changes in the output level of the Public Works Center as a change in its output level would precipitate a significant percentage change in the output level of PWC--Transportation.

The second most sensitive sector was Manpower--Dependents of Active Duty, sector nineteen. This sector had a least-squares line with a slope of 0.88. Thus, changing its input-output coefficient row would cause the output level of the model, with the parametrized row to be approximately that of the baseline output level for sector nineteen plus the baseline output level times 0.88 times delta. The intersectorial relationship between this sector and Naval Regional Medical Center--Outpatients, sector ten, was such that changing row nineteen of the A matrix produced significant percentage changes in the output level of Naval Regional Medical Center--Outpatients. Further, changing the coefficients representing Manpower--Dependents of Active Duty produced a Naval Regional Medical Center--Outpatients least-squares line with a slope of 0.27. Hence, changing row nineteen would cause the output of sector ten to be approximately that of the baseline output level for sector ten plus the baseline output level times 0.27 times delta. Thus, a change in the number of dependents would precipitate a change in the number of outpatients who visited the Naval Regional Medical Center.

The third most sensitive sector was Naval Regional Medical Center--Outpatients, sector ten. For this sector, a least-squares line slope of 0.71 was computed. This implied that if the input-output coefficients of row ten were changed, the output of the model with the changed coefficients would be approximately equal to the baseline output level for sector

ten plus the baseline output level for sector ten times 0.71 times delta.

The fourth most sensitive sector was PWC--Transportation, sector seven. Changing the input-output coefficients of row seven yielded a line with a slope of 0.62 when the output level of the model, with the changed coefficients, was compared to the baseline output level of sector seven. Thus, changing the coefficients of row seven would mean that the output of sector seven would be approximately equal to the baseline output level of sector seven plus the baseline output level of sector seven times 0.62 times delta. Coupled with this was a significant percentage change in the output level of Public Works Center, sector five. Making the aforementioned changes to row seven would produce a least-squares line for the Public Works Center with a slope of 0.19. Therefore, by changing row seven the output of the Public Works Center would be approximately equal to the baseline output level of the Public Works Center plus that baseline output level times 0.19 times delta. In terms of number of man-hours, this number was not too great, however, by the definition of significant percentage change, it was significant.

The fifth most sensitive sector to parametrization was Manpower--Civilian, sector twenty. Changing the coefficients in row twenty produced a line with a slope of 0.50 when the output level of the model, with the parametrized coefficients, for sector twenty was compared to the baseline output level for sector twenty. Thus, changing row twenty by an amount

delta would produce an output level approximately equal to the baseline output level for Manpower--Civilian, sector twenty, plus this baseline output level times 0.50 times delta.

There were other sectors one could concentrate on, however, all others had least-squares line slopes of less than 0.50. The reader might check the others by going through the figures of Section V and comparing the slopes of the least-squares lines. The measure of sensitivity used to determine the most sensitive sectors was the slope of the least-squares line through the points generated by computing percentage changes at the given values of delta.

The relationship of a change in a row of the input-output coefficient matrix to a change in the original input matrix was a simple one. The input-output coefficients, a_{ij}'s, were computed from the input matrix, B, and the total real output vector, $\overline{X}$. The algebraic expression for this transformation was

$$a_{ij} = b_{ij}/x_j$$

and since elements of the total real output vector were held constant, it was simple to compute the inverse of this transformation given a change to a_i. To show the inverse transformation, assume row i of the input-output coefficient matrix was changed by an amount k. Then

$$(1+k)a_{i\cdot} = b_{i\cdot}^{*}/x_j$$

and solving this expression for $b_{i\cdot}$ yielded

$$b_{i\cdot}^{*} = (1+k)a_{i\cdot}x_j \ .$$

Now, let's assume the elements of row one of the A matrix were decreased by ten percent and compute new values of $b_{1,1}^{*}$ where $b_{1,1}^{*}$ would be the value of $b_{1,1}$ had the original $b_{1\cdot}$ been such that the values of $a_{1\cdot}^{*}$ were computed from them. Then,

$$(1-0.10)a_{1,1} = b_{1,1}^{*}/x_1$$

which on substitution would be

$$(1-0.10)(0.00580) = b_{1,1}^{*}/1057143 \text{ requisitions}$$

or

$$(0.90)(0.00580) = b_{1,1}^{*}/1057143 \text{ requisitions.}$$

Solving this would yield

$$b_{1,1}^{*} = 5518 \text{ requisitions.}$$

Since 5518 is 90 percent of 6131, the original $b_{1,1}$, this shows that a change of k to the $a_{i.}$ implied a change of k to the corresponding $b_{i.}$. Simply stated, changing $a_{i.}$ by some amount yielded a corresponding change of the same amount to the respective $b_{i.}$.

The results of this analysis may be used to evaluate a sector's output based on a historical change in the sector's performance. Suppose a sector's actual inputs from the other sectors were increased by some percentage. The model's output, when the model was changed to reflect the new inputs, could be predicted by finding the amount of the change on the appropriate figure or in Appendix [B] and reading the percentage change from the baseline output level.

Suppose managers of the Naval Supply Center and the Naval Regional Medical Center were to ask themselves "what if the model's input-output coefficients were off by plus and/or minus ten percent? What range of requisitions or admissions might the respective sectors encounter." Thus, the sectors managers would be interested in total variability of forecasts with the given model input-output coefficients.

If the inputs to the Naval Supply Center were actually ten percent greater in magnitude than the inputs in the original model, the percentage change in the output of the Naval Supply Center would be 3.30 percent. This would imply that instead of an output of 1572270 requisitions the Naval Supply Center would have an output of 1624129 requisitions. Similarly, for the same change in the input so the Naval Supply Center the

output of PWC--Transportation would be 0.25 percent greater than the baseline output. The output of PWC--Transportation would increase from 1503492 gallons of fuel to 1507196 gallons of fuel. Thus, in order for the Naval Supply Center to output an additional 51859 requisitions, the Naval Supply Center would precipitate the use of an additional 3704 gallons of fuel from PWC--Transportation. Further the Naval Supply Center's change in output would cause a change in the output of Manpower--Civilian of 0.07 percent to 56929 manhours of an additional 38 manhours of civilian labor.

If the inputs to the Naval Supply Center were ten percent less than the inputs in the original model, the percentage change in the output of the Naval Supply Center would be -3.29 percent. This would imply an output of 1520477 requisitions. The output of PWC--Transportation would be 1499794 gallons of fuel instead of 1503492 gallons of fuel, a change of -0.25 percent. The output of Manpower--Civilian would be 56853 manhours instead of 56890 manhours, a change of -0.07 percent. The above figures would be ranges on the output levels of significant sectors, given that the coefficients for the Naval Supply Center--San Diego were within plus and minus ten percent. These ranges would be: NSC--San Diego 1520477 to 1624129 requisitions; PWC--Transportation 1499794 to 1507196 gallons of fuel; and Manpower--Civilian 56853 to 56929 manhours. These ranges would reflect both the direct and indirect inputs required for the Naval Supply Center to

operate with input-output coefficients within plus and minus ten percent of the original coefficients of the model.

The administrator of the Naval Regional Medical Center might wonder what services would be needed if the number of shore-based military personnel in the 11th Naval District was increased or decreased by ten percent. The administrator would only have to go to Appendix [B] and look under the ten percent column of Manpower--Active Duty and read off the percentage changes for the two sectors of the Naval Regional Medical Center and see that there would be 0.19 percent or 581 more admissions for a total of 310782 admissions and 1.98 percent or 34207 more outpatient visits for a total of 1760873 outpatient visits. The minus ten percent column would reveal a -0.19 percent change or an output of 309621 admissions and a -1.98 percent change or an output of 1692562 outpatient visits. Thus, the range of outputs would be: Naval Regional Medical Center--Admissions 309621 to 310782 admissions; and Naval Regional Medical Center--Outpatients 1692562 to 1760873 outpatient visits.

Managers of the various sectors of this model might use these results to predict future requirements for their sectors. It was pointed out above that predictions could be made as to increased requirements based on increased outputs for one sector. Similarly, decreased requirements and/or resources would result from a decrease in the input to a sector which would necessitate a decrease in the output of that sector.

B. RECOMMENDATIONS

Two specific areas for further study are recommended.

First, the model's input-output coefficient matrix needs to be reevaluated to see if all the zero entries are still zero. For instance, when model sectors of the original model formulation were split to form other sectors were the inputs accurately and correctly recorded? One would think that perhaps there were requisitions submitted to the Naval Supply Center in support of outpatient visits to the Naval Regional Medical Center, but none existed in the model as formulated. Perhaps it was not possible to separate the supplies that went to the Naval Regional Medical Center because of the manner in which accounting was done. Nonetheless, this is an area for further study, if possible, or perhaps a means of tracking supplies used by both sectors of the Naval Regional Medical Center might be initiated if it has not already been done.

The second area for possible further study is all sectors of the Public Works Center. The Public Works Center was the most sensitive sector of the model and divisions of the Public Works Center were all related so changes in the coefficient matrix here could be crucial to the model's output. Further work in this area could prove to be well worth the effort in terms of accurate forecasts by the model.

APPENDIX A

The Technological Coefficient Matrix, I-A

ROW(1)

0.99420	-0.10900	-0.03410	-0.01260
-0.00560	0.0	0.0	0.0
-0.45510	0.0	0.0	-0.62920
-0.59300	0.0	0.0	-1.64000
-0.90800	0.0	0.0	0.0

ROW(2)

0.0	1.00000	0.0	0.0
0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0

ROW(3)

0.0	0.0	0.98170	0.0
0.0	0.0	0.0	0.0
0.0	0.0	0.0	-1.59400
0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0

ROW(4)

0.0	0.0	0.0	1.00000
0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0

ROW(5)

0.0	0.0	0.0	0.0
1.00000	-1.00000	-0.33140	-0.05450
0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0

ROW(6)

-0.01110	0.0	-0.01470	0.0
-0.00850	1.00000	0.0	0.0
-0.14850	0.0	0.0	-23.09799
0.0	0.0	0.0	-13.75800
-13.75800	0.0	0.0	0.0

ROW(7)

-0.06620	0.0	-0.02080	0.0
-0.13110	0.0	1.00000	0.0
-0.14880	0.0	0.0	-26.81699
0.0	0.0	0.0	-7.58000
-7.58000	0.0	0.0	0.0

ROW(8)

-0.08410	0.0	-0.02710	0.0
-0.02220	0.0	0.0	1.00000
-1.57800	0.0	0.0	-57.00400
0.0	0.0	0.0	-84.44199
-84.44099	0.0	0.0	0.0

ROW(9)

0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0
1.00000	0.0	0.0	0.0
0.0	0.0	0.0	0.0
0.0	-0.10020	-0.07360	0.0

ROW(10)

0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0
0.0	1.00000	0.0	0.0
0.0	0.0	0.0	0.0
0.0	-6.62000	-3.70500	0.0

ROW(11)

0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0
0.0	0.0	1.00000	0.0
0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0

ROW(12)

0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0
0.0	0.0	0.0	1.00000
0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0

ROW(13)

0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0
1.00000	0.0	0.0	0.0
0.0	0.0	0.0	0.0

ROW(14)

0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0
0.0	0.93580	0.0	0.0
0.0	0.0	0.0	0.0

ROW(15)

0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0
0.0	-0.02840	0.99600	0.0
0.0	0.0	0.0	0.0

ROW(16)

0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0
0.0	0.0	0.0	1.00000
0.0	0.0	0.0	0.0

ROW(17)

0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0
1.00000	0.0	0.0	0.0

ROW(18)

-0.00002	-0.00005	-0.00080	-0.00001
-0.00001	0.0	0.0	0.0
-0.08060	0.0	0.0	-0.06490
-0.00710	0.0	0.0	-0.13940
-0.25510	1.00000	0.0	0.0

ROW(19)

0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0
0.0	-1.15000	1.00000	0.0

ROW(20)

-0.00070	-0.00910	-0.00008	-0.00100
-0.00070	0.0	0.0	0.0
-0.03370	0.0	0.0	-0.03950
-0.00570	0.0	0.0	-0.06470
0.0	0.0	0.0	1.00000

The Final Demand Vector, $\bar{d}$

Row	Sector	Demand	
1	NSC - SAN DIEGO	1057143.00	REQUISITIONS
2	LBEACH NAVAL SHIPYARD	794165.00	MAN-DAYS
3	INTER. MAINT. ACTIVITY	2887755.00	MAN-HOURS
4	NAVAIR REWORK FACILITY	6478878.00	MAN-HOURS
5	PUBLIC WORKS CENTER	194661.00	MAN-HOURS
6	PWC - MAINTENANCE	1074960.00	MAN-HOURS
7	PWC - TRANSPORTATION	609420.00	GALLONS
8	PWC - UTILITIES ENERGY	3751626.00	MILLION BTUS
9	NAVREGMEDCEN - ADMISS.	289142.00	ADMISSIONS
10	NAVREGMEDCEN - OUTPAT.	498157.00	OUTPATIENTS
11	NAVSTA - MILITARY PERS.	45684.00	PERSONNEL ACTIONS
12	NAVSTA - PORT SERVICES	9866.00	PORT SERVICE HOURS
13	NAS MIRAMAR - AIR OPS	109434.00	AIR OPERATIONS
14	NAS MIRAMAR - AIMD	1499711.00	MAN-HOURS
15	NAS MIRAMAR - SUPPLY	572336.00	REQUISITIONS
16	NTC - RECTRACEN	5530.00	STUDENTS
17	NTC - SERSCOLCOM	4716.00	STUDENTS
18	MANPOWER - ACTIVE DUTY	75904.00	PERSONNEL
19	MANPOWER - DEPS OF ACDU	17856.00	PERSONNEL
20	MANPOWER - CIVILIAN	28209.00	PERSONNEL

NAVAL SUPPLY CENTER--San Diego

Sector	-25%	-20%	-15%	-10%	-5%	5%	10%	15%	20%	25%
NSC - San Diego	-8.23	-6.58	-4.94	-3.29	-1.65	1.65	3.30	4.95	6.60	8.25
LBEACH NAVAL SHIPYARD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INTER.MAINT. ACTIVITY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NAVAIR REWORK FACILITY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PUBLIC WORKS CENTER	-0.20	-0.16	-0.12	-0.08	-0.04	0.04	0.08	0.12	0.16	0.20
PWC - MAINTENANCE	-0.09	-0.08	-0.06	-0.04	-0.02	0.02	0.04	0.06	0.08	0.09
PWC - TRANSPORTATION	-0.61	-0.49	-0.37	-0.25	-0.12	0.12	0.25	0.37	0.49	0.62
PWC - UTILITIES ENERGY	-0.19	-0.15	-0.11	-0.07	-0.04	0.04	0.07	0.11	0.15	0.19
NAVREGMEDCEN - ADMISS.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NAVREGMEDCEN - OUTPAT.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NAVSTA - MILITARY PERS.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NAVSTA - PORT SERVICES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NAS MIRAMAR - AIR OPS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NAS MIRAMAR - AIMD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NAS MIRAMAR - SUPPLY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NTC - RECTRACEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NTC - SERSCOLCOM	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MANPOWER - ACTIVE DUTY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MANPOWER - DEPS OF ACDU	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MANPOWER - CIVILIAN	-0.17	-0.13	-0.10	-0.07	-0.03	0.03	0.07	0.10	0.13	0.17

INTERMEDIATE MAINTENANCE ACTIVITIES

Sector	-25%	-20%	-15%	-10%	-5%	5%	10%	15%	20%	25%
NSC - SAN DIEGO	-0.04	-0.03	-0.02	-0.02	-0 01	0 01	0 02	0 02	0 03	0 04
LBEACH NAVAL SHIPYARD	0.0	0.0	0.0	0.0	0 0	0 0	0 0	0.0	0.0	0 0
INTER. MAINT. ACTIVITY	-0.60	-0.48	-0.36	-0.24	-0.12	0.12	0.24	0.36	0.48	0.60
NAVAIR REWORK FACILITY	0.0	0.0	0.0	0.0	0.0	0.0	0 0	0.0	0.0	0.0
PUBLIC WORKS CENTER	-0.02	-0.01	-0.01	-0.01	-0.00	0.00	0.01	0.01	0.01	0.02
PWC - MAINTENANCE	-0.02	-0.01	-0.01	-0.01	-0.00	0 00	0.01	0.01	0.01	0.02
PWC - TRANSPORTATION	-0.03	-0.03	-0.02	-0.01	-0.01	0.01	0.01	0.02	0.03	0.03
PWC - UTILITIES ENERGY	-0.01	-0.01	-0.01	-0.00	-0.00	0.00	0.00	0.01	0.01	0.01
NAVREGMEDCEN - ADMISS.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NAVREGMEDCEN - OUTPAT.	-0.01	-0.01	-0.01	-0.00	-0.00	0.00	0.00	0.01	0.01	0.01
NAVSTA MILITARY PERS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NAVSTA - PORT SERVICES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0 0
NAS MIRAMAR - AIR OPS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NAS MIRAMAR - AIMD	0.0	0.0	0.0	0.0	0.0	0 0	0.0	0.0	0 0	0 0
NAS MIRAMAR - SUPPLY	0.0	0.0	0.0	0.0	0.0	0.0	0 0	0.0	0.0	0 0
NTC - RECTRACEN	0.0	0.0	0.0	0.0	0.0	0.0	0 0	0.0	0 0	0.0
NTC - SERSCOLCOM	0.0	0.0	0.0	0.0	0 0	0 0	0.0	0 0	0 0	0 0
MANPOWER - ACTIVE DUTY	-0.01	-0.01	-0 01	-0.01	-0.00	0 00	0 01	0 01	0 01	0 01
MANPOWER - DEPS OF ACDU	-0.01	-0.01	-0.01	-0 00	-0 00	0.00	0.00	0.01	0 01	0 01
MANPOWER - CIVILIAN	0 0	0 0	0.0	0.0	0 0	0 0	0.0	0 0	0.0	0 0

PUBLIC WORKS CENTER

Sector	-25%	-20%	-15%	-10%	-5%	5%	10%	15%	20%	25%
NSC - SAN DIEGO	-0.22	-0.18	-0.13	-0.09	-0.05	0.05	0.09	0.14	0.18	0 23
LBEACH NAVAL SHIPYARD	0.0	0.0	0.0	0 0	0 0	0 0	0.0	0.0	0.0	0.0
INTER. MAINT. ACTIVITY	0.0	0.0	0.0	0.0	0.0	0.0	0 0	0.0	0.0	0.0
NAVAIR REWORK FACILITY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0 0	0.0
PUBLIC WORKS CENTER	-24.09	-19.32	-14.53	-9.71	-4.87	4.90	9.83	14.78	19.76	24.77
PWC - MAINTENANCE	-0.34	-0.27	-0.20	-0.14	-0.07	0.07	0.14	0.21	0.28	0.35
PWC - TRANSPORTATION	-5.45	-4.38	-3.29	-2.20	-1.10	1.11	2.23	3.35	4.48	5 61
PWC - UTILITIES ENERGY	-0.24	-0.19	-0.14	-0.10	-0.05	0.05	0.10	0.15	0.20	0.24
NAVREGMEDCEN - ADMISS.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0 0
NAVREGMEDCEN - OUTPAT.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0 0
NAVSTA - MILITARY PERS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NAVSTA - PORT SERVICES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NAS MIRAMAR - AIR OPS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NAS MIRAMAR - AIMD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NAS MIARMAR - SUPPLY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NTC - RECTRACEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0 0
NTC - SERSCOLCOM	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0 0	0 0	0.0
MANPOWER - ACTIVE DUTY	-0.01	-0.00	-0.00	-0.00	-0.00	0.00	0.00	0.00	0.00	0.01
MANPOWER - DEPS OF ACDU	0.00	0.00	0 00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MANPOWER - CIVILIAN	-0.77	-0.62	-0.47	-0.31	-0.16	0.16	0.31	0.47	0.63	0.79

PWC MAINTENANCE

Sector	-25%	-20%	-15%	-10%	-5%	5%	10%	15%	20%	25%
NSC - SAN DIEGO	-0.05	-0.04	-0.03	-0.02	-0.01	0.01	0.02	0.03	0.04	0.05
LBEACH NAVAL SHIPYARD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INTER. MAINT. ACTIVITY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NAVAIR REWORK FACILITY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PUBLIC WORKS CENTER	-5.07	-4.06	-3.04	-2.03	-1.02	1.02	2.03	3.05	4.07	5.09
PWC - MAINTENANCE	-7.97	-6.38	-4.79	-3.19	-1.60	1.60	3.20	4.80	6.40	8.01
PWC - TRANSPORTATION	-1.15	-0.92	-0.69	-0.46	-0.23	0.23	0.46	0.69	0.92	1.15
PWC - UTILITIES ENERGY	-0.05	-0.04	-0.03	-0.02	-0.01	0.01	0.02	0.03	0.04	0.05
NAVREGMEDCEN - ADMISS.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NAVREGMEDCEN - OUTPAT.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NAVSTA - MILITARY PERS.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NAVSTA - PORT SERVICES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NAS MIRAMAR - AIR OPS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NAS MIRAMAR - AIMD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NAS MIRAMAR - SUPPLY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NTC - RECTRACEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NTC - SERSCOLCOM	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MANPOWER - ACTIVE DUTY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MANPOWER - DEPS OF ACDU	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MANPOWER - CIVILIAN	-0.16	-0.13	-0.10	-0.07	-0.03	0.03	0.07	0.10	0.13	0.16

PWC - TRANSPORTATION

Sector	-25%	-20%	-15%	-10%	-5%	5%	10%	15%	20%	25%
NSC - SAN DIEGO	-0.03	-0.02	-0.02	-0.01	-0.01	0.01	0.01	0.02	0.02	0.03
LBEACH NAVAL SHIPYARD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INTER. MAINT. ACTIVITY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NAVAIR REWORK FACILITY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PUBLIC WORKS CENTER	-2.99	-2.40	-1.80	-1.20	-0.60	0.61	1.21	1.83	2.44	3.06
PWC - MAINTENANCE	-0.04	-0.03	-0.03	-0.02	-0.01	0.01	0.02	0.03	0.03	0.04
PWC - TRANSPORTATION	-15.37	-12.33	-9.27	-6.19	-3.10	3.12	6.25	9.40	12.56	15.73
PWC - UTILITIES ENERGY	-0.03	-0.02	-0.02	-0.01	-0.01	0.01	0.01	0.02	0.02	0.03
NAVREGMEDCEN - ADMISS.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NAVREGMEDCEN - OUTPAT.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NAVSTA - MILITARY PERS.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NAVSTA - PORT SERVICES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NAS MIRAMAR - AIR OPS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NAS MIRAMAR - AIMD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NAS MIRAMAR - SUPPLY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NTC - RECTRACEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NTC - SERSCOLCOM	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MANPOWER - ACTIVE DUTY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MANPOWER - DEPS OF ACDU	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MANPOWER - CIVILIAN	-0.10	-0.08	-0.06	-0.04	-0.02	0.02	0.04	0.06	0.08	0.10

PWC - UTILITIES ENERGY

Sector	-25%	-20%	-15%	-10%	-5%	5%	10%	15%	20%	25%
NSC - SAN DIEGO	-0.01	-0.01	-0.01	-0.00	-0.00	0.00	0.00	0.01	0.01	0.01
LBEACH NAVAL SHIPYARD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INTER. MAINT. ACTIVITY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NAVAIR REWORK FACILITY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PUBLIC WORKS CENTER	-1.22	-0.97	-0.73	-0.49	-0.24	0.24	0.49	0.73	0.97	1.22
PWC - MAINTENANCE	-0.02	-0.01	-0.01	-0.01	-0.00	0.00	0.01	0.01	0.01	0.02
PWC - TRANSPORTATION	-0.28	-0.22	-0.17	-0.11	-0.06	0.06	0.11	0.17	0.22	0.28
PWC - UTILITIES ENERGY	-9.22	-7.38	-5.53	-3.69	-1.84	1.84	3.69	5.53	7.38	9.22
NAVREGMEDCEN - ADMISS.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NAVREGMEDCEN - OUTPAT.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NAVSTA - MILITARY PERS.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NAVSTA - PORT SERVICES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NAS MIRAMAR - AIR OPS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NAS MIRAMAR - AIMD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NAS MIRAMAR - SUPPLY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NTC - RECTRACEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NTC - SERSCOLCOM	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MANPOWER - ACTIVE DUTY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MANPOWER - DEPS OF ACDU	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MANPOWER - CIVILIAN	-0.04	-0.03	-0.02	-0.02	-0.01	0.01	0.02	0.02	0.03	0.04

NAVREGMEDCEN - ADMISSIONS

Sector	-25%	-20%	-15%	-10%	-5%	5%	10%	15%	20%	25%
NSC - SAN DIEGO	-0.16	-0.12	-0.09	-0.06	-0.03	0.03	0.06	0.09	0.13	0.16
LBEACH NAVAL SHIPYARD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INTER. MAINT. ACTIVITY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NAVAIR REWORK FACILITY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PUBLIC WORKS CENTER	-0.07	-0.05	-0.04	-0.03	-0.01	0.01	0.03	0.04	0.05	0.07
PWC - MAINTENANCE	-0.05	-0.04	-0.03	-0.02	-0.01	0.01	0.02	0.03	0.04	0.05
PWC - TRANSPORTATION	-0.08	-0.06	-0.05	-0.03	-0.02	0.02	0.03	0.05	0.06	0.08
PWC - UTILITIES ENERGY	-0.15	-0.12	-0.09	-0.06	-0.03	0.03	0.06	0.09	0.12	0.15
NAVREGMEDCEN - ADMISS.	-1.72	-1.37	-1.03	-0.69	-0.34	0.34	0.69	1.04	1.37	1.73
NAVREGMEDCEN - OUTPAT.	-0.27	-0.22	-0.16	-0.11	-0.05	0.05	0.11	0.16	0.22	0.27
NAVSTA - MILITARY PERS.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NAVSTA - PORT SERVICES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NAS MIRAMAR - AIR OPS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NAS MIRAMAR - AIMD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NAS MIRAMAR - SUPPLY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NTC - RECTRACEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NTC - SERSCOLCOM	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MANPOWER - ACTIVE DUTY	-0.40	-0.32	-0.24	-0.16	-0.08	0.08	0.16	0.24	0.32	0.40
MANPOWER - DEPS OF ACDU	-0.35	-0.28	-0.21	-0.14	-0.07	0.07	0.14	0.24	0.28	0.35
MANPOWER - CIVILIAN	-0.32	-0.26	-0.19	-0.13	-0.06	0.06	0.13	0.19	0.26	0.32

NAVREGMEDCEN - OUTPATIENTS

Sector	-25%	-20%	-15%	-10%	-5%	5%	10%	15%	20%	25%
NSC - SAN DIEGO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LBEACH NAVAL SHIPYARD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INTER. MAINT. ACTIVITY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NAVAIR REWORK FACILTIY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PUBLIC WORKS CENTER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PWC - MAINTENANCE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PWC - TRANSPORTATION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PWC - UTILITIES ENERGY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NAVREGMEDCEN - ADMISS.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NAVREGMEDCEN - OUTPAT.	-17.79	-14.23	-10.67	-7.11	-3.56	3.56	7.11	10.67	14.23	17.79
NAVSTA - MILITARY PERS.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NAVSTA - PORT SERVICES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NAS MIRAMAR - AIR OPS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NAS MIRAMAR - AIMD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NAS MIRAMAR - SUPPLY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NTC - RECTRACEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NTC - SERSCOLCOM	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MANPOWER - ACTIVE DUTY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MANPOWER - DEPS OF ACDU	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MANPOWER - CIVILIAN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

NAS MIRAMAR - AIMD

Sector	-25%	-20%	-15%	-10%	-5%	5%	10%	15%	20%	25%
NSC - SAN DIEGO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LBEACH NAVAL SHIPYARD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INTER. MAINT. ACTIVITY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NAVAIR REWORK FACILITY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PUBLIC WORKS CENTER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PWC - MAINTENANCE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PWC - TRANSPORTATION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PWC - UTILITIES ENERGY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NAVREGMEDCEN - ADMISS.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NAVREGMEDCEN - OUTPAT.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NAVSTA - MILITARY PERS.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NAVSTA - PORT SERVICES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NAS MIRAMAR - AIR OPS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NAS MIRAMAR - AIMD	-1.69	-1.35	-1.02	-0.68	-0.34	0.34	0.69	1.04	1.39	1.75
NAS MIRAMAR - SUPPLY	-0.12	-0.10	-0.08	-0.05	-0.03	0.03	0.05	0.08	0.10	0.13
NTC - RECTRACEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NTC - SERSCOLCOM	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MANPOWER - ACTIVE DUTY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MANPOWER - DEPS OF ACDU	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MANPOWER - CIVILIAN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

NAS MIRAMAR - SUPPLY

Sector	-25%	-20%	-15%	-10%	-5%	5%	10%	15%	20%	25%
NSC - SAN DIEGO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LBEACH NAVAL SHIPYARD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INTER. MAINT. ACTIVITY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NAVAIR REWORK FACILTIY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PUBLIC WORKS CENTER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PWC - MAINTENANCE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PWC - TRANSPORTATION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PWC - UTILITIES ENERGY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NAVREGMEDCEN - ADMISS.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NAVREGMEDCEN - OUTPAT.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NAVSTA - MILITARY PERS.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NAVSTA - PORT SERVICES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NAS MIRAMAR - AIR OPS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NAS MIRAMAR - AIMD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NAS MIRAMAR - SUPPLY	-1.94	-1.55	-1.16	-0.78	-0.39	0.39	0.78	1.17	1.55	1.94
NTC - RECTRACEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NTC - SERSCOLCOM	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MANPOWER - ACTIVE DUTY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MANPOWER - DEPS OF ACDU	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MANPOWER - CIVILIAN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

MANPOWER - ACTIVE DUTY

Sector	-25%	-20%	-15%	-10%	-5%	5%	10%	15%	20%	25%
NSC - SAN DIEGO	-0.04	-0.03	-0.03	-0.02	-0.01	0.01	0.02	0.03	0.03	0.04
LBEACH NAVAL SHIPYARD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INTER. MAINT. ACTIVITY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NAVIAR REWORK FACILITY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PUBLIC WORKS CENTER	-0.02	-0.01	-0.01	-0.01	-0.00	0.00	0.01	0.01	0.01	0.02
PWC - MAINTENANCE	-0.01	-0.01	-0.01	-0.01	-0.00	0.00	0.01	0.01	0.01	0.01
PWC - TRANSPORTATION	-0.02	-0.02	-0.01	-0.01	-0.00	0.00	0.01	0.01	0.02	0.02
PWC - UTILITIES ENERGY	-0.04	-0.03	-0.02	-0.02	-0.01	0.01	0.02	0.02	0.03	0.04
NAVREGMEDCEN - ADMISS.	-0.47	-0.37	-0.28	-0.19	-0.09	0.09	0.15	0.28	0.38	0.47
NAVREGMEDCEN - OUTPAT.	-4.93	-3.94	-2.96	-1.98	-0.99	0.99	1.98	2.97	3.97	4.96
NAVSTA - MILITARY PERS.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NAVSTA - PORT SERVICES	0.0	0.0	0.0	0.0	0.0	0 0	0.0	0.0	0.0	0.0
NAS MIRAMAR - AIR OPS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NAS MIRAMAR - AIMD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NAS MIRAMAR - SUPPLY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NTC - RECTRACEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0 0
NTC - SERSCOLCOM	0.0	0.0	0.0	0 0	0.0	0.0	0.0	0.0	0.0	0 0
MANPOWER - ACTIVE DUTY	-7.32	-5.86	-4.40	-2.93	-1.47	1.47	2.94	4.42	5.89	7.37
MANPOWER - DEPS OF ACDU	-6.39	-5.12	-3.84	-2.56	-1.28	1.28	2.57	3.86	5.15	6.44
MANPOWER - CIVILIAN	-0.09	-0.07	-0.05	-0.03	-0.02	0.02	0.03	0.05	0.07	0.09

MANPOWER - DEPENDENTS OF ACTIVE DUTY

Sector	-25%	-20%	-15%	-10%	-5%	5%	10%	15%	20%	25%
NSC - SAN DIEGO	-0.07	-0.05	-0.04	-0.03	-0.01	0.01	0.03	0.04	0.05	0.07
LBEACH NAVAL SHIPYARD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INTER. MAINT. ACTIVITY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0 0	0.0
NAVAIR REWORK FACILITY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PUBLIC WORKS CENTER	-0.03	-0.02	-0.02	-0.01	-0.01	0.01	0.01	0.02	0.02	0.03
PWC - MAINTENANCE	-0.02	-0.02	-0.01	-0.01	-0.00	0.00	0.01	0.01	0.02	0.02
PWC - TRANSPORTATION	-0.03	-0.03	-0.02	-0.01	-0.01	0.01	0.01	0.02	0.03	0.03
PWC - UTILITIES ENERGY	-0.06	-0.05	-0.04	-0.03	-0.01	0.01	0.03	0.04	0.05	0.06
NAVREGMEDCEN - ADMISS.	-0.74	-0.59	-0.44	-0.30	-0.15	0.15	0.30	0.44	0.59	0.74
NAVREGMEDCEN - OUTPAT.	-6.70	-5.36	-4.02	-2.68	-1.34	1.34	2.68	4.03	5.37	6.72
NAVSTA - MILITARY PERS.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NAVSTA - PORT SERVICES	0.0	0.0	0.0	0 0	0.0	0.0	0.0	0.0	0.0	0.0
NAS MIRAMAR - AIR OPS	0.0	0.0	0.0	0.0	0.0	0 0	0.0	0 0	0 0	0.0
NAS MIRAMAR - AIMD	0.0	0.0	0.0	0.0	0 0	0.0	0.0	0.0	0.0	0.0
NAS MIRAMAR - SUPPLY	0.0	0.0	0.0	0.0	0.0	0.0	0 0	0 0	0.0	0.0
NTC - RECTRACEN	0.0	0.0	0 0	0.0	0.0	0.0	0.0	0.0	0 0	0.0
NTC - SERSCOLCOM	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0 0
MANPOWER - ACTIVE DUTY	-0.17	-0.14	-0.10	-0.07	-0.03	0.03	0.07	0.10	0.14	0.17
MANPOWER - DEPS OF ACDU	-21.94	-17.56	-13.17	-8.79	-4.39	4.40	8.80	13.20	17 61	22.02
MANPOWER - CIVILIAN	-0.14	-0.11	-0.08	-0.06	-0.03	0.03	0.06	0.08	0.11	0 14

MANPOWER - CIVILIAN

Sector	-25%	-20%	-15%	-10%	-5%	5%	10%	15%	20%	25%
NSC - SAN DIEGO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LBEACH NAVAL SHIPYARD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INTER. MAINT. ACTIVITY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NAVAIR REWORK FACILITY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PUBLIC WORKS CENTER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PWC - MAINTENANCE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PWC - TRANSPORTATION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PWC - UTILITIES ENERGY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NAVREGMEDCEN- ADMISS.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NAVREGMEDCEN - OUTPAT.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NAVSTA - MILITARY PERS.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NAVSTA - PORT SERVICES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NAS MIRAMAR - AIR OPS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NAS MIRAMAR - AIMD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NAS MIRAMAR - SUPPLY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NTC - RECTRACEN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NTC - SERSCOLCOM	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MANPOWER - ACTIVE DUTY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MANPOWER - DEPS OF ACDU	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MANPOWER - CIVILIAN	-12.60	-10.08	-7.56	-5.04	-2.52	2.52	5.04	7.56	10.08	12.60

AD-A093 270 NAVAL POSTGRADUATE SCHOOL MONTEREY CA F/G 12/2
PARAMETRIC SENSITIVITY ANALYSIS OF A REGIONAL INPUT-OUTPUT MODE--ETC(U)
JUN 80 L T WOMACK

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C        * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
C        *                                                                *
C        *  PRCGRAM TO CO A SENSITIVITY ANALYSIS OF THE NAVY PERSONNEL    *
C        *  RESEARCH & CEVELOPEMENT CENTER'S REGIONAL INPUT-OUTPUT        *
C        *  MCCEL BY MAKING PARAMETRIC CHANGES TC EACH A(I, J) IN THE     *
C        *  TECHNICAL COEFFICIENT MATRIX AND SCLVING  THE RESULTING       *
C        *  SYSTEM OF LINEAR SIMULTANEOUS EQUATIONS.  FOR KNOWLEDGE       *
C        *  CF THE MODEL, SEE "A REGIONAL INPUT-OUTPUT MOCEL FOR FORE-    *
C        *  CASTING SHCRE-EASEC NAVY WORKLCAD," NPRDC TR 78-32, AUGUST    *
C        *  1978.                                                         *
C        *                                                                *
C        * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
C        *                                                                *
C        *  PRCGRAMMEC BY LCDR LEE T. WOMACK, II, USN, 432-88-3147/111C   *
C        *                                                                *
C        *                        THESIS PRCJECT                          *
C        *                                                                *
C        * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
C        *                                                                *
C        *                                                                *
C        *   ARRAYS:                                                      *
C        *                                                                *
C        *      A      - TECHNICAL COEFFICIENT MATRIX.                    *
C        *      AINV   - A-INVERSE.                                       *
C        *      AP     - PARAMETRIZEC TECHNICAL COEFFICIENT MATRIX.       *
C        *               ALSO USED AS WORKING ARRAY FOR SCME              *
C        *               CCMPUTATIONS.                                    *
C        *      BASE   - MCDEL SCLUTION WITH CELTA FOR PARAMETRIZATICN    *
C        *               ECUAL TO ZERO.                                   *
C        *      D      - ORIGINAL DEMAND VECTOR.                          *
C        *      DEL    - VECTOR OF DELTA VALUES FOR PARAMETRIZATION.      *
C        *      OUTPUT - MATRIX CF OUTPUTS AT EACH ITERATICN CF           *
C        *               PARAMTERIZATION.                                 *
C        *      SECT   - VECTOR OF ACTIVITY NAMES.                        *
C        *      UNITS  - VECTOR OF UNITS FCR EACH SECTOR.                 *
C        *      WKAREA - WCRKAREA FOR LINV2F TO COMPUTE "I-A INVERSE."    *
C        *      XRAY   - VECTOR OF RCW VALUES CF OUTPUT.  USED TO         *
C        *               CCMPUTE CONFIDENCE INTERVALS.                    *
C        *                                                                *
C        *                                                                *
C        *   SUBRCUTINES:                                                 *
C        *                                                                *
C        *      DRIVER - RUNS THE ENTIRE PROGRAM.                         *
C        *      PARA   - THE HEART OF THE ALGCRITHM: DOES ROW & COLUMN    *
C        *               PARAMETRIZATIONS.                                *
C        *      LINV2F - CCMPUTES "I-A INVERSE."                          *
C        *      XPRINT - WRITES THE A, AINV, AND D MATRICES.              *
C        *      BMATRX - COMPUTES THE INPUT MATRIX, B.                    *
C        *      UPRINT - WRITES MATRICES OF ITERATIVE OUTPUTS.            *
C        *      CONF   - CCMPUTES CONFIDENCE INTERVALS AND WRITES         *
C        *               STATISTICS.                                      *
C        *      XCCNF  - SETS UP THE OUTPUT MATRICES TO HAVE CONFI-       *
C        *               CENCE INTERVALS COMPUTED.                        *
C        *      COMPR  - DCES COMPARISONS AND WRITES RESULTS OF PARA-     *
C        *               METRIC CHANGES.                                  *
C        *      MUL    - DCES MATRIX MULTIPLICATION TO CCMPUTE OUT-       *
C        *               PUT (X).                                         *
C        *      TABLE  - PRINTS THE (I-A) AND D MATRICES.                 *
C        *                                                                *
C        *                                                                *
C        *   VARIABLES:                                                   *
C        *                                                                *
C        *      IPRINT - PRINT CCNTRCL PARAMETER.                         *
C        *      MSIZE  - MATRIX SIZE (SQUARE MATRIX).                     *
C        *      NF     - DSRN FOR READ.                                   *
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C     *        NS      - CSRN FOR WRITE.                                    *
C     *        IWORK   - DIMENSION OF WORKAREA FOR LINV2F.                  *
C     *        MSIZE2  - MSIZE TIMES TWO.                                   *
C     *        ZL      - ZERO TOLERANCE LEVEL.                              *
C     *        IER     - ERROR COUNT USED IN LINV2F.                        *
C     *        LIL     - NUMBER OF PARAMETRIC ITERATIONS DESIRED.           *
C     *        ICOUNT  - COUNTS ROW AND COLUMN PARAMETRIC ITERATIONS.       *
C     *        IDELTA  - DELTA VALUE FOR A PARAMETRIC ITERATION.            *
C     *        N       - NUMBER OF OBSERVATIONS.                            *
C     *        IDOF    - DEGREES OF FREEDOM.                                *
C     *        TOTAL   - SUM OF X'S.                                        *
C     *        XBAR    - MEAN OF X'S.                                       *
C     *        VARX    - VARIANCE OF X'S (UNBIASED ESTIMATE).               *
C     *        SDEV    - STANDARD DEVIATION OF X'S.                         *
C     *        T       - T-STATISTIC FOR CONFIDENCE INTERVAL COMPUTATION.*
C     *        XL      - LOWER CONFIDENCE LIMIT.                            *
C     *        XL      - UPPER CONFIDENCE LIMIT.                            *
C     *        CL      - CONFIDENCE INTERVAL LENGTH.                        *
C     *        NM1     - NUMBER OF OBSERVATIONS MINUS 1.                    *
C     *        IP1     - I PLUS 1.                                          *
C     *        HOLD    - DUMMY, USED IN SORT ROUTINE.                       *
C     *        ISTART  - START PARAMETER FOR OUTPUT.                        *
C     *        ISTOP   - STOP PARAMETER FOR OUTPUT.                         *
C     *        NN      - N DIVIDED BY 2.                                    *
C     *        KN      - N DIVIDED BY 2, TIMES 2.                           *
C     *        NNP1    - N DIVIDED BY 2, PLUS 1.                            *
C     *        IN      - N DIVIDED BY 4.                                    *
C     *        INN     - N DIVIDED BY 4, TIMES 2.                           *
C     *        INP1    - N DIVIDED BY 4, PLUS 1.                            *
C     *        Q1      - LOWER QUARTILE.                                    *
C     *        Q2      - MEDIAN.                                            *
C     *        Q3      - UPPER QUARTILE.                                    *
C     *        K1      - N DIVIDED BY 2, PLUS N DIVIDED BY 4, PLUS 1.       *
C     *        K2      - N DIVIDED BY 2, PLUS N DIVIDED BY 4, PLUS 2.       *
C     *        RANGE   - RANGE OF X'S.                                      *
C     *        QRANGE  - INTERQUARTILE RANGE.                               *
C     *        QCOS    - QUARTILE COEFFICIENT OF SKEWNESS.                  *
C     *        KRND1   - INTEGER ROUND OF K1.  10 PERCENTILE INDEX OF       *
C     *                  X'S.                                               *
C     *        KRND2   - INTEGER ROUND OF K2.  90 PERCENTILE INDEX OF       *
C     *                  X'S.                                               *
C     *        PCOK    - PERCENTILE COEFFICIENT OF KURTOSIS.                *
C     *                                                                     *
C     *                                                                     *
C     * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
C
      DIMENSION A(25, 25), AINV(25, 25), AP(25, 25), BASE(25), D(25),
     1 DEL(25), OUTPUT(25, 50), SECT(25, 24), UNITS(25, 20),
     2 WKAREA(750), XRAY(25)
C
C     READ THE INITIALIZING PARAMETERS.
      READ (4, 101) IPRINT, MSIZE, NF, NS
C
      IWORK = (MSIZE ** 2) + 5 * MSIZE
      MSIZE2 = 2 * MSIZE
C
      CALL DRIVER (A, AINV, AP, BASE, D, DEL, OUTPUT, SECT, UNITS,
     1 WKAREA, XRAY, IPRINT, IWORK, MSIZE, MSIZE2, NF, NS)
C
      WRITE (NS, 102)
C
      STOP
C
  101 FORMAT (.7I5 )
  102 FORMAT (' ', ///, ' ALL COMPUTATIONS NOW COMPLETE, WITH SUMMARY',
     1 ' DATA LISTED ABOVE.  HAVE A NICE DAY.' )
C
      END
      SUBROUTINE DRIVER (A, AINV, AP, BASE, D, DEL, OUTPUT, SECT, UNITS,
     1 WKAREA, XRAY, IPRINT, IWORK, MSIZE, MSIZE2, NF, NS)
C
```

```
      DIMENSION A(MSIZE, MSIZE), AINV(MSIZE, MSIZE), AP(MSIZE, MSIZE),
     1 BASE(MSIZE), D(MSIZE), DEL(MSIZE), OUTPUT(MSIZE, MSIZE2),
     2 SECT(MSIZE, 24), UNITS(MSIZE, 20), WKAREA(IWORK), XRAY(MSIZE)
C
      ZL = 1.0E-6
C
C     READ IN THE A COEFFICIENT MATRIX.
      DO 201 J = 1, MSIZE
         READ (NF, 204)   (A(I, J), I = 1, MSIZE)
  201 CONTINUE
C
C     READ IN THE DEMAND MATRIX.
      READ (NF, 204)   (D(I), I = 1, MSIZE)
C
C     *    DIMENSIONALITY OF 24 COINCIDES WITH THE DIMENSION    *
C     *    OF 24 IN SECT(MSIZE, 24).                            *
C
C     READ EACH SECTOR'S IDENTIFICATION.
      DO 202 I = 1, MSIZE
         READ (NF, 205)   (SECT(I, J), J = 1, 24)
  202 CONTINUE
C
C     READ EACH SECTOR'S UNITS.
      DO 203 I = 1, MSIZE
         READ (NF, 206)   (UNITS(I, J), J = 1, MSIZE)
  203 CONTINUE
C
      CALL BMATRX (A, AP, D, SECT, ZL, MSIZE, NF, NS)
C
C     WRITE THE HEADING AND PRINT THE A AND D MATRICES.
      IF ( IPRINT .EQ. 0 )   WRITE (NS, 207)
      IF ( IPRINT .EQ. 1 )   WRITE (NS, 208)
      CALL XPRINT (A, D, SECT, IPRINT, MSIZE, NF, NS)
C
      CALL PARA (A, AINV, AP, BASE, D, DEL, OUTPUT, SECT, UNITS,
     1 WKAREA, XRAY, ZL, IPRINT, IWORK, MSIZE, MSIZE2, NF, NS)
C
      RETURN
C
  204 FORMAT (7F10.0)
  205 FORMAT (24A1)
  206 FORMAT (20A1)
  207 FORMAT ('1THE ORIGINAL "A AND D" MATRICES:')
  208 FORMAT ('1THE ORIGINAL "A" MATRIX:')
C
      END
      SUBROUTINE PARA (A, AINV, AP, BASE, D, DEL, OUTPUT, SECT, UNITS,
     1 WKAREA, XRAY, ZL, IPRINT, IWORK, MSIZE, MSIZE2, NF, NS)
C
      DIMENSION A(MSIZE, MSIZE), AINV(MSIZE, MSIZE), AP(MSIZE, MSIZE),
     1 BASE(MSIZE), D(MSIZE), DEL(MSIZE2), OUTPUT(MSIZE, MSIZE2),
     2 SECT(MSIZE, 24), UNITS(MSIZE, 20), WKAREA(IWORK), XRAY(MSIZE)
C
C     COMPUTE THE BASE VECTOR FOR COMPARISON.
      DO 302 I = 1, MSIZE
C
         DO 301 J = 1, MSIZE
            AP(I, J) = A(I, J)
            IF ( I .NE. J )   AP(I, J) = -AP(I, J)
            IF ( I .EQ. J )   AP(I, J) = 1.0 - AP(I, J)
  301    CONTINUE
C
  302 CONTINUE
C
      CALL LINV2F (AP, MSIZE, MSIZE, AINV, 1, WKAREA, IER)
C
      DO 304 I = 1, MSIZE
         BASE(I) = 0.0
C
         DO 303 J = 1, MSIZE
            IF ( ABS(AINV(I, J)) .LE. ZL )   GO TO 303
            BASE(I) = BASE(I) + AINV(I, J) * D(J)
```

```
  303    CONTINUE
C
  304 CONTINUE
C
C     READ THE NUMBER OF DELTA POINTS AND THE DELTA VALUES.
      READ (NF, 320) LIL
      READ (NF, 321)     (DEL(I), I = 1, LIL)
C
C     PRINT TABLES FOR THE THESIS DRAFT.
      CALL TABLE (AP, D, SECT, UNITS, MSIZE, NF, NS)
C
C     DO ROW AND COLUMN PARAMETRICS FOR EACH DELTA VALUE.
      DO 315 LEE = 1, LIL
         WRITE (7, 322) DEL(LEE)
         ICOUNT = 0
C
C        * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
C
C                           PARAMETRIC ROW
C
C        * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
C
         DO 310 I = 1, MSIZE
C
            DO 306 IL = 1, MSIZE
C
               DO 305 JL = 1, MSIZE
                  AP(IL, JL) = A(IL, JL)
  305          CONTINUE
C
  306       CONTINUE
C
            DO 307 J = 1, MSIZE
               IF ( ABS(AP(I, J)) .LE. ZL )   GO TO 307
               AP(I, J) = AP(I, J) + DEL(LEE) * AP(I, J)
  307       CONTINUE
C
            DO 309 II = 1, MSIZE
C
               DO 308 JJ = 1, MSIZE
                  IF ( II .NE. JJ )   AP(II, JJ) = -AP(II, JJ)
                  IF ( II .EQ. JJ )   AP(II, JJ) = 1.0 - AP(II, JJ)
  308          CONTINUE
C
  309       CONTINUE
C
            CALL LINV2F (AP, MSIZE, MSIZE, AINV, 1, WKAREA, IER)
C
            CALL MUL (AINV, D, OUTPUT, ZL, ICOUNT, MSIZE, MSIZE2)
  310    CONTINUE
C
C        * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
C
C                           PARAMTERIC COLUMN
C
C        * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
C
         DO 316 J = 1, MSIZE
C
            DO 312 IL = 1, MSIZE
C
               DO 311 JL = 1, MSIZE
                  AP(IL, JL) = A(IL, JL)
  311          CONTINUE
C
  312       CONTINUE
C
            DO 313 I = 1, MSIZE
               IF ( ABS(AP(I, J)) .LE. ZL )   GO TO 313
               AP(I, J) = AP(I, J) + DEL(LEE) * AP(I, J)
  313       CONTINUE
C
```

```
          DC 315 II = 1, MSIZE
C
             DO 314 JJ = 1, MSIZE
                IF ( II .NE. JJ )    AP(II, JJ) = -AP(II, JJ)
                IF ( II .EQ. JJ )    AP(II, JJ) = 1.0 - AP(II, JJ)
 314         CCNTINUE
C
 315      CONTINUE
C
          CALL LINV2F (AP, MSIZE, MSIZE, AINV, 1, WKAFEA, IER)
C
          CALL MUL (AINV, D, OUTPUT, ZL, ICOUNT, MSIZE, MSIZE2)
 316      CCNTINUE
C
          IF ( DEL(LEE) .LT. ZL )    IDELTA = IFIX((DEL(LEE) * 100.C)
     1    - C.5)
          IF ( DEL(LEE) .GT. ZL )    IDELTA = IFIX((DEL(LEE) * 100.C)
     1    + C.5)
          CALL CCMPR (AP, BASE, OUTPUT, SECT, IDELTA, MSIZE, MSIZE2, NF,
     1    NS)
          IF ( IPRINT .NE. 0 .AND. IPRINT .NE. 1 )    GO TO 318
          WRITE (NS, 323) MSIZE, MSIZE2, IDELTA
          CALL UPRINT (OUTPUT, SECT, ICOUNT, MSIZE, NF, NS, 1)
 317      ISTART = 1
          IF ( IPRINT .EC. 2 )    GC TO 319
          CALL XCONF (OUTPUT, SECT, XRAY, IDELTA, ISTART, MSIZE, MSIZE,
     1    MSIZE2, NF, NS)
          ISTART = MSIZE + 1
          CALL XCCNF (OUTPUT, SECT, XRAY, IDELTA, ISTART, MSIZE2, MSIZE,
     1    MSIZE2, NF, NS)
          GO TO 319
 318      IF ( LEE .EC. LIL )    GC TO 317
 319  CCNTINUE
C
      RETURN
C
 320  FCRMAT (I5)
 321  FCRMAT (7F10.0)
 322  FCRMAT (' PARAMETRICS WITH A DELTA VALUE OF', F6.2)
 323  FCRMAT ('1THE ', I2, ' BY ', I2, ' PARAMETRIZED RCW',
    1 ' ANC COLUMN MATRIX WITH DELTA =', I4, ' PERCENT.', ///)
C
          ENC
      SUBRCUTINE XPRINT (A, D, SECT, IPRINT, MSIZE, NF, NS)
C
      DIMENSION A(MSIZE, MSIZE), D(MSIZE), SECT(MSIZE, 24)
C
C     * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
C
C     SUBRCUTINE TO WRITE CUT INTERMEDIATE RESULTS CF "THESIS,"
C     WHICH IS A PRCGRAM TO CHECK SENSITIVITY IN THE I/C MODEL.
C
C     * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
C
C     *       IF IPRINT = 0, PRINT BOTH THE A AND D MATRICES.      *
C     *       IF IPRINT = 1, PRINT CNLY THE A MATRIX.              *
C     *       IF IPRINT = 2, PRINT CNLY THE D MATRIX.              *
C
      IF ( IPRINT .NE. C .AND. IPRINT .NE. 1 )    GO TO 403
C
C     SETUP TO PRINT OUT THE MATRIX PASSED BY COLUMNS CF 10 ANC
C     RCWS CF MSIZE, UNTIL THE MATRIX IS COMPLETELY PRINTED WITH
C     CCLUMN HEADERS.
      ISTART = 1
      ISTOP = 1C
 4C1  IF ( ISTOP .GT. MSIZE )   ISTOP = MSIZE
C
      WRITE (NS, 406)  (I, I = ISTART, ISTOP)
C
      DC 402 I = 1, MSIZE
         WRITE (NS, 407)    (A(I, J), J = ISTART, ISTCP)
 4C2  CCNTINUE
```

```
C
      IF ( ISTOP .EQ. MSIZE)   GO TO 403
      ISTART = ISTART + 10
      ISTOP = ISTOP + 10
      WRITE (NS, 408)
      GO TO 401
C
  403 IF ( IPRINT .NE. 0 .AND. IPRINT .NE. 2 )     RETURN
C
C     WRITE OUT THE DEMAND MATRIX (MSIZE X 1).
  404 WRITE (NS, 409)
C
      DO 405 I = 1, MSIZE
         WRITE (NS, 410)  (SECT(I, J), J = 1, 24), D(I)
  405 CONTINUE
C
      RETURN
C
  406 FORMAT (' ', ////, 8X, I2, 9I13)
  407 FORMAT ('0', 10F13.5)
  408 FORMAT ('1')
  409 FORMAT ('1THE ORIGINAL DEMAND VECTOR:', //)
  410 FORMAT ('0',24A1, F16.2)
C
      END
      SUBROUTINE BMATRX (A, B, D, SECT, ZL, MSIZE, NF, NS)
C
      DIMENSION A(MSIZE, MSIZE), B(MSIZE, MSIZE), D(MSIZE), SECT(MSIZE,
     1 24)
C
      DO 502 I = 1, MSIZE
C
         DO 501 J = 1, MSIZE
            B(I, J) = 0.0
            IF ( ABS(A(I, J)) .LT. ZL )    GO TO 501
            B(I, J) = A(I, J) * D(J)
  501    CONTINUE
C
  502 CONTINUE
C
      WRITE (NS, 503)
      CALL UPRINT (B, SECT, MSIZE, MSIZE, NF, NS, 3)
C
      RETURN
C
  503 FORMAT ('1THE INPUT MATRIX, B:', //)
C
      END
      SUBROUTINE UPRINT (ARRAY, SECT, NCOLS, MROWS, NF, NS, ITYPE)
C
      DIMENSION ARRAY(MROWS, NCOLS), SECT(MROWS, 24)
C
      IF ( ITYPE .NE. 1 )    GO TO 2
      ISTART = 1
      ISTOP = 5
      ICOLN = 5
      GO TO 601
C
    2 ISTART = 1
      ISTOP = 10
      ICOLN = 10
C
  601 IF ( ISTOP .GT. NCOLS )    ISTOP = NCOLS
C
      IF ( ITYPE .EQ. 1 )     WRITE (NS, 604)    (I, I = ISTART, ISTOP)
      IF ( ITYPE .NE. 1 )     WRITE (NS, 610)    (I, I = ISTART, ISTOP)
      WRITE (NS, 605)
C
      DO 602 I = 1, MROWS
         IF ( ITYPE .EQ. 1 )      WRITE (NS, 606)  (SECT(I, J), J = 1, 24),
     1   (ARRAY(I, J), J = ISTART, ISTOP)
         IF ( ITYPE .EQ. 2 )      WRITE (NS, 608)  (SECT(I, J), J = 1, 24),
```

```
1    (ARRAY(I, J), J = ISTART, ISTOP)
      IF ( ITYPE .EQ. 3 )   WRITE (NS, 609)  (SECT(I, J), J = 1, 24),
    1 (ARRAY(I, J), J = ISTART, ISTOP)
 6C2 CCNTINUE
C
      IF ( ISTOP .EG. NCOLS )   GC TO 6C3
      ISTART = ISTART + ICCUN
      ISTCF = ISTOP + ICOUN
      WRITE (NS, 607)
      GC TC 601
C
 6C3 FETURN
C
 604 FCRMAT (' ', 4CX, I2, 4I20)
 6C5 FCRMAT ('0')
 606 FCRMAT ('C', 24A1, 5F20.2)
 6C7 FCRMAT ('1')
 608 FCRMAT ('0', 24A1, 10F10.2)
 6C9 FCRMAT ('0', 24A1, 10F10.0)
 61C FCRMAT (' ', 3CX, I2, 9I10)
C
      ENC
      SUBRCUTINE CONF (X, N, NF, NS)
C
      CIMENSICN X(N)
C
C     * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
C
C     SUBRCUTINE TC COMPUTE A 95% CONFICENCE INTERVAL, GIVING THE
C     LCWER AND UPPER LIMITS, FOR THE MEAN CF A STRING CF NUMBERS.
C
C     * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
C
      IF ( N .LE. 1 )   RETURN
      ICCF = N - 1
      TCTAL = 0.0
      ZL = 1.0E-6
C
      CC 701 I = 1, N
         TCTAL = TOTAL + X(I)
 7C1 CCNTINUE
C
      XEAR = TCTAL / FLCAT(N)
      VARX = 0.0
C
      CC 7C2 I = 1, N
         VARX = VARX + ( X(I) - XEAR ) ** 2
 7C2 CCNTINUE
C
      VARX = VARX / FLOAT(ICOF)
      SCEV = VARX ** 0.5
C
      IF ( ICOF .GT.  0 .AND. IDOF .LE.  3 )     T = 3.18
      IF ( ICOF .GT.  3 .ANC. IDOF .LE.  7 )     T = 2.36
      IF ( ICOF .GT.  7 .AND. IDOF .LE. 15 )     T = 2.13
      IF ( IDCF .GT. 15 .ANC. IDOF .LE. 20 )     T = 2.09
      IF ( IDOF .GT. 20 .AND. IDOF .LE. 25 )     T = 2.06
      IF ( ICOF .GT. 25 .AND. IDOF .LE. 30 )     T = 2.04
      IF ( IDCF .GT. 30 .AND. IDOF .LE. 40 )     T = 2.02
      IF ( ICCF .GT. 40                    )     T = 2.CC
C
      XL = XBAR - ( T * SDEV / (FLOAT(N) ** 0.5 ))
      XU = XBAR + ( T * SDEV / (FLOAT(N) ** 0.5 ))
      CL = XU - XL
C
C     RCUTINE TC SORT THE ARRAY AND PRINT OUT THE LIST CF NUMBERS
C     IN THE SCRTED ARRAY.
C
      NM1 = N - 1
C
      CC 7C4 I = 1, NM1
         IP1 = I + 1
```

```
C
          DO 703 J = IP1, N
             IF ( X(I) .LE. X(J) )  GO TO 703
             HOLD = X(I)
             X(I) = X(J)
             X(J) = HOLD
  703     CONTINUE
C
  704 CONTINUE
C
      IF ( N .GT. 100 )   GO TO 706
C
      WRITE (NS, 713)
C
      ISTART = 1
      ISTOP = 10
  705 IF ( ISTOP .GT. N )  ISTOP = N
      WRITE (NS, 714)     ( X(I), I = ISTART, ISTOP )
      IF ( ISTOP .EQ. N ) GO TO 706
      ISTART = ISTART + 10
      ISTOP = ISTOP + 10
      GO TO 705
C
C     WRITE OUT THE STATISTICS COMPUTED ABOVE.
C
  706 WRITE (NS, 715) N, IDOF, TOTAL, XBAR, VARX, SDEV, T, XL, XU, CL
C
C     * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
C
C     COMPUTE QUARTILES AND COEFFICIENTS OF SKEWNESS AND KURTOSIS.
C
C     * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
C
C     IS N EVEN OR ODD?
      NN = N / 2
      KN = NN * 2
      NNP1 = NN + 1
C     IF N ODD BRANCH TO 708.
      IF ( KN .LT. N )   GO TO 708
C
C                        * * * * * *
C                        *         *
C                        * N EVEN. *
C                        *         *
C                        * * * * * *
C
      IN = NN / 2
      INN = IN * 2
      INP1 = IN + 1
C     IS N/2 EVEN OR ODD?  BRANCH TO 707 IF ODD.
      IF ( INN .LT. NN )   GO TO 707
C
C     N EVEN AND N/2 EVEN.  COMPUTE QUARTILES.
      K1 = NN + IN
      K2 = K1 + 1
      Q1 = ( X(IN) + X(INP1) )  /  2.0
      Q2 = ( X(NN) + X(NNP1) )  /  2.0
      Q3 = ( X(K1) + X(K2)   )  /  2.0
      GO TO 710
C
C     N EVEN AND N/2 ODD.  COMPUTE QUARTILES.
  707 K2 = NN + INP1
      Q1 = X(INP1)
      Q2 = ( X(NN) + X(NNP1) )  /  2.0
      Q3 = X(K2)
      GO TO 710
C
C                        * * * * * *
C                        *         *
C                        * N ODD.  *
C                        *         *
C                        * * * * * *
```

```
C
  708 IN = NN / 2
      INN = IN * 2
      INP1 = IN + 1
C     IF N/2 ODD, BRANCH TO 709.
      IF ( INN .LT. NN )   GO TO 709
C
C     N ODD AND N/2 EVEN.  COMPUTE QUARTILES.
      K1 = NN + IN + 1
      K2 = K1 + 1
      Q1 = ( X(IN) + X(INP1) )  /  2.0
      Q2 = X(NNP1)
      Q3 = ( X(K1) + X(K2) )  /  2.0
      GO TO 710
C
C     N ODD AND N/2 ODD.  COMPUTE QUARTILES.
  709 K2 = NN + INP1 + 1
      Q1 = X(INP1)
      Q2 = X(NNP1)
      Q3 = X(K2)
C
C     QUARTILE COMPUTATIONS COMPLETE, COMPUTE SKEWNESS AND KURTOSIS
C     COEFFICIENTS.
C
  710 RANGE = X(N) - X(1)
      QRANGE = Q3 - Q1
      IF ( ABS(QRANGE) .LT. ZL )   GO TO 711
      QCOS = (Q3 + (-2.0 * Q2) + Q1) / QRANGE
  711 IF ( ABS(QRANGE) .LT. ZL )   QCOS = 0.0
      KRND1 = (0.1 * FLOAT(N)) + 0.5
      KRND2 = (0.9 * FLOAT(N)) + 0.5
      IF ( ABS(QRANGE) .LT. ZL )   GO TO 712
      PCOK = (QRANGE * 0.5) / ( X(KRND2) - X(KRND1) )
  712 IF ( ABS(QRANGE) .LT. ZL )   PCOK = 0.0
C
C     WRITE OUT THE COMPUTED STATISTICS AND STOP.
C
      WRITE (NS, 716)  X(1), X(N), RANGE, Q1, Q2, Q3, QRANGE, QCOS,
     1 PCOK
C
      RETURN
C
  713 FORMAT (' THE SORTED ARRAY OF NUMBERS:', // )
  714 FORMAT ('0', 10F13.2 )
  715 FORMAT (' ', ///, ' STATISTICS:', //,
     1 ' N = ', I7, /,
     2 ' DOF = ', I5, /,
     3 ' TOTAL = ', F18.2, /,
     4 ' MEAN = ', F19.2, /,
     5 ' VARX = ', F19.2, /,
     6 ' SDEV = ', F19.2, /,
     7 ' T-STAT = ', F17.2, /,
     8 ' LOWER CONFIDENCE LIMIT = ', F19.2, /,
     9 ' UPPER CONFIDENCE LIMIT = ', F19.2, //,
     * ' CONFIDENCE INTERVAL LENGTH = ', F15.2 )
  716 FORMAT ('0MINIMUM = ', F20.2, /,
     1 ' MAXIMUM = ', F20.2, /,
     2 ' RANGE = ', F22.2, /,
     3 ' LOWER QUARTILE = ', F13.2, /,
     4 ' MEDIAN = ', F21.2, /,
     5 ' UPPER QUARTILE = ', F13.2, /,
     6 ' INTER-QUARTILE RANGE = ', F14.2, /,
     7 ' QUARTILE COEFFICIENT OF SKEWNESS = ', F9.4, /,
     8 ' PERCENTILE COEFFICIENT OF KURTOSIS = ', F7.4, ///)
C
      END
      SUBROUTINE XCONF (ARRAY, SECT, XRAY, IDELTA, ISTART, ISTOP,
     1 MSIZE, MSIZE2, NF, NS)
C
      DIMENSION ARRAY(MSIZE, MSIZE2), SECT(MSIZE, 24), XRAY(MSIZE)
C
      IF ( ISTART .LT. MSIZE )   WRITE (NS, 803) IDELTA
```

```
      IF ( ISTART .GT. MSIZE )   WRITE (NS, 804) IDELTA
C
      DC 802 I = 1, MSIZE
         JJ = 0
C
         DO 801 J = ISTART, ISTOP
            JJ = JJ + 1
            XRAY(JJ) = ARRAY(I, J)
  801    CONTINUE
C
         IF ( I .GT. 1 )   WRITE (NS, 805)
         WRITE (NS, 806)   (SECT(I, JJ), JJ = 1, 24)
         CALL CONF (XRAY, MSIZE, NF, NS)
C
  802 CONTINUE
C
      RETURN
C
  803 FORMAT ('1STATISTICS ON PARAMETRIZED ROWS WITH DELTA =', I4,
     1 ' PERCENT.', ///)
  804 FORMAT ('1STATISTICS ON PARAMETRIZED COLUMNS WITH DELTA =', I4,
     1 ' PERCENT.', ///)
  805 FORMAT ('1')
  806 FORMAT (' *  *  *  DEMAND FOR - - ', 24A1, ' *  *  *', ///)
C
      END
      SUBROUTINE CONFR (AP, BASE, OUTPUT, SECT, IDELTA, MSIZE,
     1 MSIZE2, NF, NS)
C
      DIMENSION AP(MSIZE, MSIZE), BASE(MSIZE), OUTPUT(MSIZE, MSIZE2),
     1 SECT(MSIZE, 24), AVGROW(25), AVGCOL(25), PCTR(25), PCTC(25)
C
      WRITE (NS, 910) IDELTA
C
      DO 903 I = 1, MSIZE
         TOTAL = 0.0
C
         DO 901 J = 1, MSIZE
            TOTAL = TOTAL + OUTPUT(I, J)
  901    CONTINUE
C
         AVGROW(I) = TOTAL / FLOAT(MSIZE)
         TOTAL = 0.0
         ISTART = MSIZE + 1
C
         DO 902 J = ISTART, MSIZE2
            TOTAL = TOTAL + OUTPUT(I, J)
  902    CONTINUE
C
         AVGCOL(I) = TOTAL / FLOAT(MSIZE)
  903 CONTINUE
C
      WRITE (NS, 911)
C
      DO 904 I = 1, MSIZE
         PCTR(I) = ( (AVGROW(I) / BASE(I)) * 100.0 ) - 100.0
         PCTC(I) = ( (AVGCOL(I) / BASE(I)) * 100.0 ) - 100.0
         WRITE (NS, 912)   (SECT(I, J), J = 1, 24), BASE(I), AVGROW(I),
     1   PCTR(I), AVGCOL(I), PCTC(I)
  904 CONTINUE
C
      WRITE (NS, 913) IDELTA
C
      DO 905 I = 1, MSIZE
         II = I + MSIZE
         PCTR(I) = ( (OUTPUT(I, I) - BASE(I) ) / BASE(I) ) * 100.0
         PCTC(I) = ( (OUTPUT(I, II) - BASE(I) ) / BASE(I) ) * 100.0
         WRITE (NS, 914)   (SECT(I, J), J = 1, 24), BASE(I),
     1   OUTPUT(I, I), PCTR(I), OUTPUT(I, II), PCTC(I)
  905 CONTINUE
C
      DO 909 J = 1, MSIZE
```

```
      JJ = J + MSIZE
      WRITE (NS, 913) IDELTA
      WRITE (NS, 915) J, J, J, JJ
C
      DO 906 I = 1, MSIZE
         PCTR(I) = ( (OUTPUT(I, J) - BASE(I) ) / BASE(I) ) * 100.0
         IF ( IDELTA .EQ. 10 )    AP(I, J) = PCTR(I)
         PCTC(I) = ( (OUTPUT(I, JJ) - BASE(I) ) / BASE(I) ) * 100.0
         WRITE (NS, 914)    (SECT(I, K), K = 1, 24), BASE(I),
     1   OUTPUT(I, J), PCTR(I), OUTPUT(I, JJ), PCTC(I)
  906 CONTINUE
C
      TOTR = 0.0
      TOTC = 0.0
C
      DO 907 K = 1, MSIZE
         TOTR = TOTR + PCTR(K)
         TOTC = TOTC + PCTC(K)
         PMEANR = TOTR / FLOAT(K)
         PMEANC = TOTC / FLOAT(K)
  907 CONTINUE
C
      WRITE (NS, 916) PMEANR
C
      DO 908 K = 1, MSIZE
         IF ( ABS(PCTR(K)) .GT. ABS(PMEANR) )    WRITE (NS, 917) K,
     1   (SECT(K, L), L = 1, 24), PCTR(K), PMEANR
  908 CONTINUE
C
  909 CONTINUE
C
      IF ( IDELTA .EQ. 10 )    WRITE (NS, 918)
      IF ( IDELTA .EQ. 10 )    CALL UPRINT (AP, SECT, MSIZE, MSIZE,
     1 NF, NS, 2)
C
      RETURN
C
  910 FORMAT ('1ROW AND COLUMN MEANS FOR EACH SECTOR WITH DELTA =',
     1 I4, ' PERCENT.', ///)
  911 FORMAT (' ', 'SECTOR', 27X, 'BASE', 19X, 'ROW MEAN', 6X,
     1 '% DIF (ROW)', 11X, 'COL MEAN', 6X, '% DIF (COL)')
  912 FORMAT ('0', 24A1, 5X, F12.2, 12X, F12.2, 7X, F5.2, 13X, F12.2,
     1 7X, F5.2)
  913 FORMAT ('1EFFECT OF ROW PARAMETRICS ON EACH SECTOR WITH',
     1 ' DELTA =', I4, ' PERCENT.', ///, ' SECTOR', 27X,
     2 'BASE', 18X, 'ROW OUTPUT', 5X, '% DIF (SEC)',
     3 11X, 'COL OUTPUT', 5X, '% DIF (COL)')
  914 FORMAT ('0', 24A1, 5X, F12.2, 12X, F12.2, 7X, F7.2, 11X, F12.2,
     1 7X, F7.2)
  915 FORMAT ('0ROW', I3, ' - COLUMN', I3, ' OF OUTPUT',
     1 ' * * * * COL', I3, ' - COLUMN', I3, ' OF OUTPUT.)')
  916 FORMAT ('0', //, ' SUMMARY FOR PARAMETRICS ON ROWS:  MEAN = ',
     1 F6.4, ' %.')
  917 FORMAT ('0PERCENTAGE CHANGE FOR SECTOR ', I2, ',', 1X, 24A1, /,
     1 ' OF ', F6.2, '%',
     2 ' GREATER IN ABSOLUTE MAGNITUDE THAN THE MEAN PERCENTAGE CHANGE',
     3 ' OF ', F6.2, '%.')
  918 FORMAT ('1MATRIX OF PERCENTAGE CHANGES WITH DELTA EQUAL TO 10%:',
     1 ///)
C
      END
      SUBROUTINE MUL (AINV, D, OUTPUT, ZL, ICOUNT, MSIZE, MSIZE2)
C
      DIMENSION AINV(MSIZE, MSIZE), D(MSIZE), OUTPUT(MSIZE, MSIZE2)
C
      ICOUNT = ICOUNT + 1
C
      DO 1002 I = 1, MSIZE
         OUTPUT(I, ICOUNT) = 0.0
C
         DO 1001 J = 1, MSIZE
            IF ( ABS(AINV(I, J)) .LE. ZL )    GO TO 1001
```

```
            OUTPUT(I, ICOUNT) = OUTPUT(I, ICOUNT) + AINV(I, J) * D(J)
 1001    CONTINUE
C
 1002 CONTINUE
C
      RETURN
      END
      SUBROUTINE TABLE (AP, D, SECT, UNITS, MSIZE, NF, NS)
C
      DIMENSION AP(MSIZE, MSIZE), D(MSIZE), SECT(MSIZE, 24),
     1 UNITS(MSIZE, 20)
C
C     WRITE TABLES OF "(I-A)" AND "D" MATRICES.
      WRITE (NS, 1103)
C
      DO 1101 I = 1, MSIZE
         IF ( I .EQ. 11 .OR. I .EQ. 21 )   WRITE (NS, 1103)
         WRITE (NS, 1104) I, (AP(I, J), J = 1, MSIZE)
 1101 CONTINUE
C
      WRITE (NS, 1103)
C
      DO 1102 I = 1, MSIZE
         WRITE ( NS, 1105) (SECT(I, J), J = 1, 24), D(I),
     1   (UNITS(I, J), J = 1, 20)
 1102 CONTINUE
C
      RETURN
C
 1103 FORMAT ('1', //////)
 1104 FORMAT (' ', 26X, 'ROW(', I2, ')', 7(/, 4F14.5))
 1105 FORMAT ('0', 4X, 24A1, 2X, F11.2, 1X, 20A1)
C
      END
```

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